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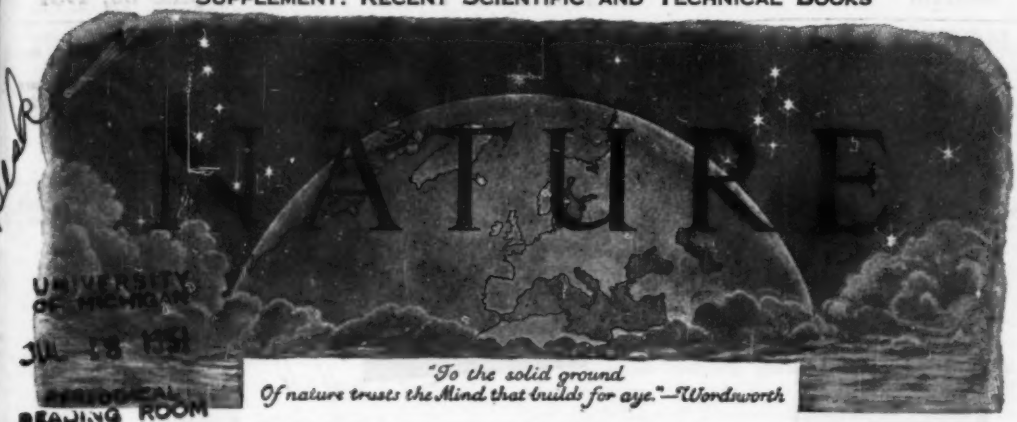

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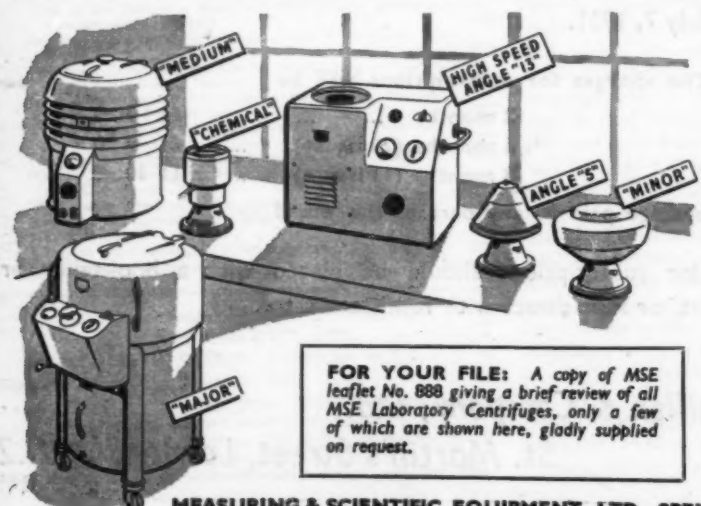

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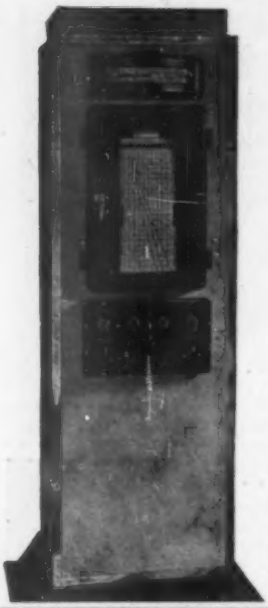

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NATURE

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COUNCIL FOR THE PROMOTION OF FIELD STUDIES

THE activities of the Council's four residential Field Study and Research Centres have been the subject of a recent series of articles in *Nature**. The Council was founded in 1943 to provide working facilities and expert guidance in the various field sciences. Some thousands of students of all ages have directly benefited by the Council's work, and many more could do so if the means were made available; but it seems to be but dimly comprehended in Britain, especially in official circles, that the need for increasing the facilities and opportunities for field-work becomes greater and more insistent year by year. Faced at present with a scarcity of raw materials and threatened in the next few decades with a world food shortage, it is high time that man, if he wants to survive, began to take more serious stock of himself and his habitat. Thus the growing popular interest in field natural history during and since the War may be instinctively self-preservative and is certainly well founded. Intellectually also both botanists and zoologists are freeing themselves from the necessarily predominating claims of taxonomy characteristic of the earlier development of their subjects, and turning their attention to ecological and behaviour problems which require carefully planned and prolonged field observation at first hand.

The difficulties under which the Council labours are twofold, related to both maintenance and capital costs. It would seem obvious that potential students need encouragement to pursue studies which are essential both to themselves and to the community; but by the recent decision of the Ministry of Education that students' fees must be raised to a figure sufficient to cover the cost of the salaries of scientific staff as well as the domestic overheads of the Centres, students are deterred and often prevented from going to the Field Centres. Adequate grants-in-aid from local authorities (with some notable exceptions) are in general only obtainable with difficulty, if indeed at all, and many worth-while students do not fall within the categories eligible for such grants. Thus it is highly probable that the increase in charges imposed to solve the Council's maintenance problems will, in fact, have the reverse effect. In any event, it would seem that this decision was made arbitrarily, and without due regard to the particular merits of the case. The Council's Field Centres, while performing the valuable educational function which is widely acknowledged, need also increased opportunity to pursue and encourage those fundamental and long-term observational researches which their unrivalled position in areas of particular interest and importance would enable them to do. This more advanced work demands small groups, whereas for economic reasons the emphasis at present has to be laid on the large groups of more elementary students from schools and training colleges. The explanation, no doubt, is that these are the sections of the com-

* *Nature*, **167**, 712, 757, 801, 886 (1951).

munity which fall within the jurisdiction of the Ministry of Education. It is surely arguable that if, when assessing its need for grant, the Ministry is not in a position to take a comprehensive view of all sections of the Council's work, the obligation to review the position should be placed upon a government department which is. It is certainly a pity that these valuable Field Study and Research Centres should find themselves in financial difficulties at such an early stage in their career; for apart from developing the work already begun, new ideas and projects will perforce have to be nipped in the bud.

We would urge that the Council, both by the special nature and the particular need of its contribution to the nation, has a claim to fair and even generous treatment by the Exchequer. It is also clearly the responsibility of all the present local authorities, if they are to retain the confidence of the community in their ability to administer education in their areas with vision and efficiency, to make adequate grants for field-work to students of the field sciences and arts, to enable them to obtain a unique and fundamental part of their technical training at the Council's Field Centres. The articles already published on the work of these Field Centres show that they have the facilities for botanical, zoological, geological, geographical and other studies that no academic department could hope to emulate; and this applies especially to the schools and universities in our larger towns.

The needs of the Council for capital grants are perhaps less complex, though none the less urgent. As a voluntary body, the obligation rests upon the Council to raise some considerable proportion of its needs from voluntary sources. So far it has raised a total of some £30,000 in this way—no mean achievement. This has been done chiefly through the generosity of the Carnegie Trustees and the Worshipful Company of Goldsmiths. These two bodies, however, have limited their grants to one Centre each, and a recent Treasury grant of £10,000 received through the Development Commission has enabled the Council to go forward with the completion of adaptation and equipment of these two Centres—at Flatford Mill and Malham Tarn. The other two Centres, Juniper Hall and Dale Fort, while adequately equipped to run full and successful courses (incidentally the total numbers of students visiting these Centres last year exceeded those at Malham and Flatford) are sorely in need of capital funds, and will labour under a serious disadvantage in the immediate future if their standard of equipment and domestic comfort cannot be brought up to that of the other two. It is clear that the Treasury is much more ready to meet a deficiency where some proportion of the necessary funds are first found elsewhere; but voluntary sources of help are fast dwindling. Here, surely, is an opportunity for industry, which can but be vitally concerned in the welfare of the community, to consider what can be done to help a body by the efforts of which sufficient has already been achieved to begin a transformation in the teaching of an important group of subjects as significant as that introduced by the provision of laboratories.

HISTORY OF BIOLOGY

A History of Biology

A General Introduction to the Study of Living Things. By Charles Singer. Revised edition. Pp. xxxv+579. (London: H. K. Lewis and Co., Ltd., 1950.) 35s. net.

DR. CHARLES SINGER is a leading authority on the history of biology, as well he need be to cover so comprehensive a field as the history of zoology and botany from Hippocrates to the present time in a single volume of less than six hundred pages. His purpose is to investigate the historical issues in question in an authoritative and philosophical spirit, "so as to lead up to the study of biological problems". He holds that the story must be brought up to date if it is to be treated as a coherent whole, but admits that he cannot cover, of his own knowledge, the whole area of the subject of which he treats. If, therefore, he courageously attempts this difficult task the critic should bear in mind the warning of Starr Jordan that we must not expect a degree of accuracy which the subject does not permit.

The work is fully and admirably illustrated, and the literary style is always clear and felicitous, and in places eloquent. The main subjects dealt with include an admirable summary of the rise of ancient science, the renaissance of modern science, the comparative method in morphology and physiology, distribution in space and time, evolution, cell theory, biogenesis and abiogenesis, embryology, sex, and the mechanism of heredity. Dr. Singer has not found it necessary to re-write this second edition, which agrees with the first of 1931 apart from minor corrections; but the sections on viruses, the theories of sex and the gene, and heredity in general have been re-cast and brought up to date.

Dr. Singer is at his best when dealing with issues of large-scale dimensions, and he has no use for what he stigmatizes as the "jackdaws of historical research". In this, however, he forgets that in his own recent historical work he is by no means insensible to the pleasures of meticulosity, and the present "History" could not have been written but for the labours of those inquisitive and industrious 'birds'.

It would be possible to write at length on Dr. Singer's distinguished handling of so much diverse and conflicting material, and if agreement with his views would not always be possible it must be conceded that his attitude towards controversial questions is always attractive and unprejudiced. The relevant literature is staggering in bulk, and much of it is important. Hence any author, however learned and conscientious, must be prepared for corrections and additions, of which a few representative examples, apart from minor slips in matters of date and priority, may be mentioned. P. 105. The useful figure illustrating the action of the heart and blood vessels according to Galen does not show that the blood entering the right ventricle from the liver is assumed to be returned to that organ by the same vessel. In the first edition of this figure, also by Dr. Singer, published in 1922, this backward flow is indicated. P. 111. Quite rightly the discovery of the circulation of the blood is attributed to Harvey, but the contribution to the discovery by Cæsalpinus, which was handsomely disposed of by Willis in 1878, should have been mentioned in view of recent dubious claims on his behalf. Also the two "clacks" referred to by Harvey are surely the two auriculo-ventricular

valves, and not the semilunar valves of the aorta and pulmonary artery. P. 135. In the section on the first scientific societies, one of the oldest and most important of them all, the Academia Naturæ Curiosorum, is not mentioned. P. 165. The statement that Leeuwenhoek did not apply himself to any topic continuously for very long is commonly made but quite inaccurate. On the contrary, having hit upon a new and promising line of research, he showed great persistence and determination in getting as much out of it as he was capable. P. 196. Cuvier was classifying the animal kingdom into Vertébrés and Invertébrés in 1800; but Lamarck was still using "animaux sans Vertèbres" in 1822. P. 203. The anatomical theatre at Padua was erected in 1594, and the "stipple engraving" is a photograph of an old drawing which was first published in 1844. P. 318. There is no "butterfly that imitates a wasp", but the moth *Aegeria apiformis* mimics the hornet. Other cases of such mimicry in the Lepidoptera are doubtful. P. 407. In the first edition of 1931 a quotation from J. S. Haldane's Silliman Lectures published in 1922 is correctly recorded, but in the present edition the quotation is wrongly attributed to J. B. S. Haldane, the date of birth remaining the same! P. 441. The discussion of spontaneous generation does not do full justice to Tyndall, who, and not Pasteur, gave the final blow to the alleged occurrence of that phenomenon in organic infusions. Pasteur's results would have gone the other way had he encountered the *Bacillus subtilis*, and it was only when Tyndall, in his own person, had been confronted with *both* types of result that the stage was set for the final solution by that great experimenter. P. 469. The Biogenetic Law should not be attributed to von Baer, whose views on generation were more subtle and by no means consistent with it, but to the version of the law popularized by Haeckel, who also invented the term itself in 1872. The embryological section in general needs bringing up to date. P. 487. The "clouded yellow butterfly" is actually the cinnabar moth, and the larvæ of the "blue-bottle fly" are clearly those of *Eristalis*. P. 490. The paragraph on the microtome should include mention of J. Hill's "cutting engine" of 1770 and the ingenious instrument devised by Geo. Adams, jun., in 1787.

The work is well produced, but some of the illustrations have suffered from over-inking. The index lists the names of authors and does not include subjects.

F. J. Cole

PHYSICS—CLASSICAL AND MODERN

A Hundred Years of Physics

By Prof. William Wilson. (100 Years Series.) Pp. 319. (London: Gerald Duckworth and Co., Ltd., 1950.) 21*s*. net.

THE emotional content of the words 'classical' and 'modern', those rallying cries of Victorian school stories, often seems attached to them when they are applied to physics—at least in popular usage. A natural antithesis of outlook, an implied loyalty to a competitive side, a suggestion of placid tradition versus ruthless utility are all part of the atmosphere surrounding them. Perhaps this is a little imaginative; but there is no doubt that many intending students of physics set out on their task fully believing that an intelligent grasp of modern work is possible without a thorough grounding in the classical principles. Prof. William Wilson, the distinguished author of notable works on modern physics, illustrates the point in "A Hundred Years of Physics" that, indeed, classical and modern physics are not incompatibles; he traces the unifying theoretical structure through its development of the past hundred years and shows how surely the ideas of to-day are the outcome of the labours of the past. This is a book directed primarily to the physicist (but well within the grasp of the interested general reader) which explains what physicists have been trying to do and what they are now attempting. It is not a historical book in the ordinary sense, in that biographical details and social matters are barely referred to.

Since the turn of the century the great developments of physics have been due more to a change in terms of reference than to any revolution of outlook or of scientific method. The older natural philosopher worked with the same aims and ideals as does the present-day physicist. A hundred years ago men were striving to relate phenomena within the grand and imposing unity of Euclid's geometry and Newton's mechanics; to-day, there is still a striving after such unity, but no longer a belief that Euclidean geometry and Newtonian mechanics are established for all time. The change, too, has been a gradual one, each successive stage marked by a period of conflicting ideas and resolution of difficulties. Prof. Wilson suggests (a little sadly, one feels) that the picture is now almost complete so far as concerns the middle regions of physics that lie between the two extremes of nuclear and cosmical phenomena, though possible developments in the physics of living matter are foreshadowed.

The opening chapters deal with the principle of the conservation of energy. It is hard nowadays to appreciate the difficulties that the equivalence of heat and work presented in the light of Carnot's principle, which indeed Joule at one time tended to reject, and to realize that even after the great contribution of Clausius it remained for Planck to complete the reconciliation; it is also salutary to be reminded that the matter presented so smoothly in the text-books was not so easily won in the first place. A survey of the ether, from Fresnel's drag calculation to the Michelson–Morley experiment, leads on to the special theory of relativity, and Prof. Wilson points out here why the absolute time and space of Newton present no problems in ordinary mechanics—the application of the laws of motion never involves the ideas of absolute time and space at all in such cases.

Maxwell's equations are presented as an integration of electromagnetism, and the chapter dealing with this appears, in its title, to raise a question of importance to teachers. Can an integrated electromagnetism be taught as such to elementary students, or should they work through the historical development of electricity and magnetism in the conventional way?

The general theory of relativity, and the developments of the past forty years, are very well explained, particularly the pioneer work on the Bohr atom in which the author played a great part (though this is briefly and inconspicuously recorded); this again is salutary, for the story of the gradual piecing together of the outer structure of the atom is that of a great period of endeavour which the student of to-day,

with the whole embodied for him in a wave-equation, might all too readily underrate. Thinking in terms of the general reader, I here felt uneasy about the statement in the preface that the reader needs very little previous knowledge of physics; but it is only fair to say that anyone who had mastered the earlier chapters would have fortified himself well for the remainder, and that there is a well-chosen list of reference books of varying difficulty provided at the end.

To quote the preface again, there is much in the book that is addressed to both students and teachers of science. This is a very modest claim for a work which, while covering in outline all the main lines of progress, keeps before the reader always the interrelation between them. One cannot help feeling that the subject must often appear to students like a block of self-contained flats, each admirably designed by an architect who has somehow omitted the stairs; the staircase here is a prominent and central feature of the work. Teachers will admire the craftsmanship of an excellent teacher, and will be able to refer to the book for chapter and verse when warning the impatient young that an apprenticeship in classical physics is essential for a full appreciation of modern ideas.

G. R. Noakes

ELECTRONS AND MATTER

Theory of Electrons

By Prof. L. Rosenfeld. (Selected Topics in Modern Physics, 1.) Pp. xv+120. (Amsterdam: North-Holland Publishing Co., 1951.) 7.50 f.; 15s.

THE interpretation of the macroscopic electrical and magnetic properties of matter in terms of the behaviour of individual atoms and molecules plays so important a part in modern physics that it comes as a surprise to realize, on reading Prof. L. Rosenfeld's book, that up to now there has been no accessible text devoted exclusively to a discussion of the fundamental principles. Most students, unless they are prepared to seek out the relevant material from comprehensive treatises, must be content with only the vaguest conception of the elegant chain of argument by which, for example, Maxwell's equations and the phenomena of optical dispersion and scattering are linked with the mechanics of simple atomic models. In a sense, the present book does nothing to alter the situation, since it shows that, like most fundamental theories, Lorentz's theory of electrons cannot be understood clearly without much careful thought. In fact, the subject is much more suitable for postgraduate than for undergraduate study. On the other hand, the whole book is so illuminated by Prof. Rosenfeld's enthusiasm that there is every encouragement for the serious student to master the niceties of the arguments.

The book varies greatly in complexity and depth of treatment. The first three chapters, occupying nearly half the book, set out the basic theorems concerning the microscopic field variables and their relation to macroscopic fields, and the dynamical theorems which lead to an understanding of, among other things, the gyromagnetic effects. The treatment here is generally very clear, except where occasionally, as on p. 16, over-conciseness leads to needless obscurity. The rest of the book deals with various topics—the magnetic properties of materials, dispersion theory, scattering of light and critical opalescence. The first is considered only in an elementary way (there is, intentionally, no attempt to present the detailed quantum theory of paramagnetism and ferromagnetism), and dispersion theory is treated at two levels, of which the second, the rigorous treatment, left me gasping for breath. The discussions of scattering and opalescence are, like the rigorous theory of dispersion, of much greater difficulty than the rest of the book and tend to make it top-heavy; but Prof. Rosenfeld in his preface disarms criticism by admitting that he could not resist the temptation to enlarge on so delightful a theme. In any event, it is useful to have these difficult matters clearly set out, and the resulting lack of unity does not in any way detract from the value of the book.

The publishers are to be congratulated on the appearance of their product and on the remarkable achievement of publication within four months of receipt of the manuscript.

A. B. Pippard

STATISTICAL DECISION FUNCTIONS

Statistical Decision Functions

By Prof. Abraham Wald. (Wiley Publications in Statistics.) Pp. ix+179. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 40s. net.

THE recent death of Prof. Abraham Wald in an aeroplane crash in India has deprived theoretical statistics of one of its ablest and most prolific researchers. This book is his last and most advanced work, and as a contribution to scientific methodology is likely to rank high for many years to come.

The book is best considered as part of a general movement which dates from the early days of the Second World War. The desire for economy in sampling led to the development of sequential analysis, in which a decision whether to accept or reject a batch is based on a sample of undetermined size selected one by one. Wald himself published a standard work on this subject in 1947. Later generalizations included the extension of the theory to the case of multiple decisions, where more than a simple dichotomy between acceptance and rejection is involved. This in turn, linking up with the theory of strategy in games and the testing of statistical hypotheses, has led to a general theory of decisions based on statistical data. There is a great deal of ground to be covered before this subject finds its feet. In the meantime, Wald's book marks a stage in one line of development to which he himself has contributed a great deal.

Wald, by training and inclination, was a synthesizer and a generalizer. He was at his best and his happiest when extending the scope of previous results and bringing apparently distinct lines of thought into one canon. Although his exposition is usually clear and never loose, this tendency towards generality makes his work rather abstract and difficult for a beginner to follow. Stochastic processes are encountered on p. 1, abstract spaces on p. 3, Borel fields on p. 6 and minimax strategies on p. 25. In short, this is a very difficult book, and the ordinary reader will require a certain amount of preparation for it. Nevertheless, it represents some extremely stimulating lines of development in the theory of inference and experimentation which look as if they may have a permanent value.

BRITAIN'S SCIENTIFIC SHRINES (4)

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

THE MIDLAND COUNTIES

OF the four counties surrounding London, Surrey, Kent and Essex have already been traversed, leaving Middlesex as a base for carrying the survey to the north and north-west into the Midland counties. A century ago, Middlesex had London for its capital, and though even to-day it has its Guildhall in Westminster, the formation of the County of London robbed it of much of its territory and it now extends crescent-wise around the west and north of London, stretching from Staines to Enfield.

In the southern part of the crescent lies Teddington, the home of the great National Physical Laboratory founded in 1899; but two hundred years ago, when Teddington was a village, it was the home of the Rev. Stephen Hales (1677–1761), a born investigator who has been called "a father of physiology, agriculture and public health". A Kentish man by birth, he became a fellow of Corpus Christi College, Cambridge, which in 1927 commemorated the two hundred and fiftieth anniversary of his birth, the interest aroused leading to the publication of his biography by Dr. Clark-Kennedy. For fifty years Hales held the living at Teddington, and he was buried beneath the church tower which he had restored at his own expense. He had many friends, and it was Augusta, Princess of Wales, mother of George III, who erected the memorial to him in Poets' Corner, in Westminster Abbey. Not far from Teddington is Heston, where Sir Joseph Banks (1744–1820) is buried. At the time of Hales's death, Banks was an undergraduate at Oxford, but already studying botany and thus preparing himself for the great part he was to play in British science. His voyages, his friendships, his generosity and his long reign at Somerset House as president of the Royal Society gave him a unique position, which he used to further many notable projects. Though he inherited the family estate at Revesby, Lincolnshire, where other Bankses have memorials, he lived mainly in London but died at Isleworth. The position of his grave in Heston churchyard is uncertain; but there is a memorial to him in the church.

Ealing, Greenford Green, Harrow, Hendon, Finchley and Enfield are other places in Middlesex associated with eminent men of science. At Ealing, Thomas Henry Huxley (1825–95) was born, and he lies in St. Marylebone Cemetery, Finchley. It was at Greenford Green that Sir William Henry Perkin (1838–1907), at the age of nineteen and with the aid of his father, began manufacturing the first aniline dye. Most of his life was passed in the district, and his grave is at South Harrow. In St. Mary's churchyard at Hendon a stone with arms carved on it marks the grave of Sir Stamford Raffles (1781–1826), the founder alike of the colony of Singapore and of the Zoological Society. His statue by Chantry is in Westminster Abbey. Sir Peter Russell (1816–1905), the founder of the Russell School of Engineering at Sydney, New South Wales, also lies in St. Marylebone Cemetery, while at Enfield, a place familiar to the lovers of Charles Lamb, is the tomb of the famous surgeon, John Abernethy (1764–1831). "His practice", it is said, "increased with his celebrity, which the eccentricity and rudeness of his manners contributed to heighten."

Travelling northward from Hendon into Hertfordshire, St. Albans is soon reached. Its ancient abbey overlooks the park covering the site of the Roman city of Verulamium; Roman walls, a villa and a theatre are there awaiting inspection, while many of the 'finds' are to be seen in the attractive Verulamium Museum, the entrance to which has a tablet to the archæologist Mrs. R. E. M. Wheeler.

Within a stone's-throw of the Museum is St. Michael's Church, containing the vault and the statue of Francis Lord Bacon (1561–1626). Born in London, Bacon died at the home of the Earl of Arundel at Highgate, but was brought hither to the parish in which is situated his estate of Gorhambury. Many opinions have been expressed as to Bacon's influence on the growth of modern science; but were he alive to-day he would assuredly be interested to see what is done at the Rothamsted Experimental Station at Harpenden, only five miles from St. Albans. Through the pioneering work of Sir John Bennet Lawes, Bt. (1814–1900), who succeeded to the estate at Rothamsted, this spot has become world-famous, and the experiments on the growing of crops begun by Lawes in 1843 are still carried on by the Trust he founded. A fine monument to him is in Harpenden Church, and in the churchyard can be seen the tombs of his collaborators, Sir Joseph Henry Gilbert (1817–1901) and Robert Warington (1838–1907), whose "Chemistry of the Farm" reached its nineteenth edition in his lifetime. Hertfordshire to-day also includes the John Innes Horticultural Institution, founded at Merton, Surrey, in 1910, under the will of John Innes (1829–1904) and directed at first by William Bateson (1861–1926), the pioneer in England of Mendelism or, as he called it, 'Genetics'. The Merton site becoming too congested, the Trustees of the Institution purchased the big mansion and park at Bayfordbury, about a mile south of Hertford, and there the work is carried on under the direction of Dr. C. D. Darlington.

While Hertfordshire has attractions for the agriculturist and the horticulturist, Bedfordshire appeals to the zoologist, for it is on the edge of the Dunstable Downs that the great Whipsnade Zoological Park has been laid out, largely through the efforts of Sir Peter Chalmers Mitchell (1864–1945), long the secretary of the Zoological Society. But Bedfordshire also has a shrine for mechanicians and clockmakers, for the village of Northill, about halfway between Bedford and Biggleswade, was the birthplace of Thomas Tompion (1639–1713), who is buried in Westminster Abbey. Every horologist, every astronomer, every collector knows of Tompion as the father of English clockmaking. At one time he was Master of the Worshipful Company of Clockmakers, founded in 1632, and the Company, to commemorate its tercentenary in 1933, erected the marble tablet to Tompion to be seen in Northill Church.

Bedfordshire is Bunyan's county. Huntingdonshire has associations with Cromwell and Pepys; but its most famous man of science is Sir Michael Foster (1836–1907), son of a Huntingdon surgeon. His

text-book on physiology was a classic, he started the *Journal of Physiology*, and at Cambridge, it has been said, "founded one of the finest Schools of Physiology that has ever existed". As a writer, lecturer, organizer and speaker he was outstanding. In his old age he returned to his native town and now lies not far from where he was born and educated. But long before Foster's time, Huntingdonshire gave to science Richard Dunthorne (1711–75), the butler of Pembroke Hall, who has a niche in the gallery of Cambridge astronomers, and Olinthus Gilbert Gregory (1774–1841), who long held the chair of mathematics at the Royal Military Academy, Woolwich, and whose name was inscribed on the foundation stone of the University of London, now University College, in Gower Street. Dunthorne was born in Ramsey, and Gregory at Yaxley, and both were of humble parentage.

Lying to the west of Bedfordshire and Huntingdonshire, Northamptonshire has among its places of interest the village of Ecton, five miles east of Northampton, the home of the forbears of Benjamin Franklin, where a bronze tablet was erected in 1910 by the citizens of the United States. Franklin himself is said to have visited Ecton in 1758, the year before his lightning conductor was fixed on St. Paul's Cathedral. Of other villages associated with men of science, Fawsley, five miles south of Daventry, was the birthplace of John Wilkins (1614–72); Perry St. Paul, near Towcester, was the birthplace of the learned Dr. Edward Bernard (1638–97), who succeeded Wren as Savilian professor of astronomy; while Sibbertoft, ten miles from Kettering, had for many years as its vicar the Rev. Miles Joseph Berkeley (1803–99), who gave Kew Gardens his herbarium of ten thousand fungi. John Wilkins was the son of an Oxford goldsmith but was born in the home of his maternal grandfather, the Puritan divine John Dod, who was afterwards rector of Fawsley. As Warden of Wadham College, Oxford, Master of Trinity College, Cambridge, vicar of St. Lawrence Jewry, London, and finally as Bishop of Chester, Wilkins exerted a moderating influence in church affairs but never lost his interest in science. It was said that "he deserves more than anyone to be esteemed the founder of the Royal Society". He died at the house of Dr. Tillotson in Chancery Lane, London, and was buried in St. Lawrence Jewry, only the walls of which now stand.

If instead of leaving Middlesex by a northern route a traveller chooses to go eastward through Buckinghamshire, he will find at Slough, now a great industrial district, a scientific shrine equalling in interest Darwin's house in Kent, for in Windsor Road, Slough, stands Observatory House, the scene of the labours of Sir William Herschel. When after his discovery of Uranus, Herschel was invited in 1782 to become private astronomer to George III, he removed from Bath to Datchet, not far from Windsor, but four years later took the house at Slough, then a village. To this house in 1788 he brought his bride, the wealthy widow, Mrs. Pitt, whose maiden name was Mary Baldwin, and in this house their only son, Sir John Herschel, was born. Herschel himself died there in 1822 and was buried in the chancel of the near-by church of St. Laurence, Upton, and ten years later his widow was buried with him. To one is a large tablet with a long Latin inscription by Dr. Goodall, the Provost of Eton, and to the other a smaller one inscribed in English giving the date of her birth as June 13, 1750, and that of her death as January 6, 1832.

After his father's death, Sir John Herschel continued to live with his widowed mother; but soon after her death, towards the end of 1833, he left with his wife and children for the Cape and was away four years. Soon after his return to Britain, he dismantled the great forty-foot telescope and in 1840 went to live at Hawkhurst, Kent. For half a century the house at Slough was occupied by strangers, but in 1888 four of the Herschel family returned there, and it has been occupied by Herschels ever since. Of Sir John Herschel's twelve children, the first son, Sir William James Herschel (1833–1917), who succeeded to his father's baronetcy, was long in the Indian Civil Service; the second, Alexander Stewart Herschel (1836–1907), was professor of experimental physics first at Glasgow and then at Durham; and the third, Colonel John Herschel (1837–1921), was deputy superintendent of the Great Trigonometrical Survey of India. One, if not more, of these is buried in St. Laurence; but the third and last baronet, the Rev. Sir John Herschel (1869–1950), is buried in the parish church of St. Mary. He was long the owner of Observatory House, and it was in accordance with his wishes that the Slough Town Council in 1939 took steps for its preservation on account of its special historical interest.

Buckinghamshire has other places of scientific interest, for it was at the home of Dr. John Lee (1783–1866) at Hartwell, near Aylesbury, that the British Meteorological Society was founded on April 3, 1850. Sir William Ramsay (1852–1916) passed his last days in the county, being buried at Hazlemere, near High Wycombe, while at Stone the distinguished hydrographer and astronomer, Admiral William Henry Smyth (1788–1865), and his son-in-law, Sir William Henry Flower (1831–99), the director of the British Museum (Natural History), South Kensington, are buried. Of the neighbouring county of Oxfordshire and of the University of Oxford itself, it is not proposed to write, for, as with Cambridge, the guide-books contain many references to the statues and other memorials to men of science.

For the purpose of beginning a survey of the north Midlands, there is no more convenient centre than Birmingham, which itself was the meeting-place of some of the leading men of science and engineers of the eighteenth century. Through two of these, Dr. Erasmus Darwin (1731–1802), the Lichfield physician, poet and botanist, and Matthew Boulton (1728–1809), the Birmingham manufacturer, the once famous Lunar Society came into existence, the members of which met at one another's houses at times of full moon, because in those days a full moon was of considerable service in finding the way home at night. The members included John Baskerville (1706–75), the leading printer; John Whitehurst (1713–88), the Derbyshire clockmaker, who wrote an "Enquiry into the Original State and Formation of the Earth"; Josiah Wedgwood (1730–95), the great potter; Joseph Priestley (1733–1804); Captain James Keir (1735–1820), the translator of Macquer's "Dictionary of Chemistry"; James Watt (1836–1919); Dr. William Withering (1741–99), physician and botanist; Richard Lovell Edgeworth (1744–1817), a great experimenter and versatile inventor; Samuel Galton (1753–1832), a Quaker manufacturer and natural philosopher; and William Murdock. Many and spirited were the discussions the members had, and when Erasmus Darwin in 1782 removed to Derbyshire after practising twenty-six years at Lichfield, he wrote to Boulton: "I am here cut off

from the milk of science which flows in such abundant streams from your learned Lunatics, and which, I assure you, is a very great regret to me". He tried to mitigate his loss by founding in 1784 the Philosophical Society of Derby.

Not the least interesting part of the story of these famous men is that relating to the intermarriage of members of the Darwin, Wedgwood and Galton families, by which Erasmus Darwin became the grandfather of both Charles Darwin and Sir Francis Galton (1822–1911), the founder of eugenics. Then, too, Charles Darwin, like his father, Dr. Robert Waring Darwin (1766–1848), married into the Wedgwood family. There are numerous biographies of most of the "Lunatics", as well as many memorials to them and their fellows. Erasmus Darwin, who died at Breadsall Priory, Derbyshire, is commemorated by a tablet in Lichfield Cathedral; in Handsworth Church are the busts of Boulton and Murdock and the statue of Watt, and one of the several statues of Priestley, who died in the United States, stands in the centre of Birmingham. There are memorials to Wedgwood at Stoke-on-Trent; Keir is buried in the churchyard at West Bromwich, and Withering's bust is to be seen in Edgbaston Old Church. St. Francis Galton is buried at Claverdon, west of Warwick, and in the chapel of Erdington Orphanage, near Birmingham, is a bust of Sir Josiah Mason (1795–1881), the pen manufacturer who founded Mason College, from which the University of Birmingham sprang.

The counties which surround Warwickshire all contributed to the Industrial Revolution, and here and there are found memorials to some of the pioneers. It was in Derby that Sir John Lombe (1683–1739) set up in 1717 his famous silk-spinning mill, the fine gates to which are still preserved, and it was at Duffield, near Derby, that John Heathcoat (1783–1861), the inventor of lace-making machinery, was born. Belper, Derby, and other places are associated with Jedediah Strutt (1726–97) and his descendants, while Sir Richard Arkwright (1732–92) has his memorial at Cromford, where he built the first power-driven cotton-spinning mill. Wormhill, Derbyshire, was the birthplace of the great canal builder, James Brindley (1716–72), who lies at Newchapel, Staffordshire. George Stephenson (1781–1848) lies in Trinity Church, Chesterfield; his grave in the chancel is covered by a stone inscribed "G. S. 1848". From Nottinghamshire came the Elizabethan inventor of the stocking frame, William Lee (1550?–1610?), while Marnham was the home of the Cartwright family, from which came the Rev. Edmund Cartwright. The south of Staffordshire was as noted for its ironworks as the north was for its potteries, and this district and Shropshire saw the work of the masterful John Wilkinson (1728–1808) and of the Abraham Darbys of Coalbrookdale. Wilkinson and the third Abraham Darby (1750–91) together built the remarkable cast-iron bridge over the River Severn, and in doing so erected a memorial which the authorities have decided shall be preserved. The neighbouring town, Ironbridge, is named after the bridge. Shropshire was also the scene of much fine work by Telford, while so recently as 1949 a tablet was erected at Bridgnorth to the memory of Richard Trevithick and his fellow engineer, John Urpeth Rastrick (1780–1856).

Reverting to the survey of places with scientific instead of industrial associations, the eastern part of Leicestershire is remarkable for containing the birthplaces of no fewer than four men who left their mark on the history of science: Dr. John Bainbridge (1582–1643), the Rev. William Whiston (1667–1752), Prof. Roger Cotes (1682–1716) and Thomas Simpson (1710–61). Bainbridge, the Ashby-de-la-Zouch boy who became first a schoolmaster, then a physician and lastly an astronomer, was chosen by Sir Henry Savile as the first Savilian professor, and as such he is buried and commemorated, with the first Savilian professor of geometry, Henry Briggs, in Merton College Chapel, Oxford. Whiston and Cotes were both rector's sons, the former being born at Norton-juxta-Twycross, not far from the Warwickshire town of Atherstone, and the latter at Burbage, two miles from Hinckley. Whiston became successor to Newton as Lucasian professor of mathematics, and Cotes was made the first Plumian professor of astronomy at Cambridge, Whiston being one of the electors. Cotes died when only thirty-three, and was buried in Trinity College Chapel; but Whiston lived to the age of eighty-four, weathering storm after storm. Owing to his heterodox views, he found himself excluded first from the University, then from the Church, and then from the Royal Society; but those who wish to know more of him should borrow his "Memoirs", which are both frank and entertaining. He died at his daughter's house at Lyndon, Rutlandshire. Simpson had none of the early advantages of Cotes or Whiston, being but the son of a weaver of Market Bosworth, but he raised himself to the first rank of British mathematicians and was one of the predecessors of Olinthus Gregory at Woolwich. He died at Market Bosworth, but is buried at Sutton Cheney, on the border of the battlefield of Bosworth.

Before leaving Leicestershire, a word should be said of the famous Robert Bakewell (1725–95), the farmer of Dishley Grange, near Loughborough, who was visited by all who wanted to see the finest cattle and sheep in Britain. In Dishley Grange grounds is a ruined church and in one corner is Bakewell's tomb, restored somewhat in 1929 but again requiring attention.

There is a wonderful diversity in the records of the lives of men of science, some of whom have had to struggle against the most adverse conditions and then, having made important contributions, pass away almost unnoticed. Such a one was George Green (1793–1841), the miller-mathematician of Sneinton, in his day a hamlet, but now a suburb of the City of Nottingham. The son of a baker who became a miller and the owner of a mill, the burnt-out shell of which is now all that remains, George Green grew up as his father's assistant; but in between the hours given to the working of the mill he managed to master the works of Laplace and his contemporaries, and in 1828 at the age of thirty-five published by subscription his now-famous "Essay on the Application of Mathematical Analysis to the Theories of Electricity and Magnetism". Though the "Essay" did not reach the right quarters, it attracted some attention locally; and after his father's death had left Green independent, he entered Gonville and Caius College, Cambridge. He was then forty. His first "Essay" was followed by other papers on sound, light and other subjects, the last being read to the Cambridge Philosophical Society on May 20, 1839. Ill-health then limited his activities, and two years later, on May 31, 1841, he died at Sneinton and was buried in the same grave as his father and mother in St. Stephen's churchyard. What is known of him,

his family and his work is told in "A Biography of George Green", published in 1946 by Mr. H. G. Green, of the University of Nottingham.

Derbyshire has already been referred to as the last home of Erasmus Darwin; but long before his day it saw the birth of Flamsteed, who was born at the village of Denby but attended Derby School. In the latest Official Handbook to Derby is a photograph of the school, and others of All Saints' Church and a house in Exeter Street bearing a tablet to show that it was the birthplace of Herbert Spencer (1820–1903), the son of a schoolmaster who interested him in entomology. In All Saints' Church are memorials to some of the Cavendish family, and in a vault lies Henry Cavendish (1731–1810), the famous natural philosopher who was taken there after the close of his strangely secluded life at Clapham, South London. An earlier scientific member of the family, Sir Charles Cavendish (1591–1654), who it is said invited Descartes to England, is buried at Bolsover, while the generous Sir William Cavendish, seventh Duke of Devonshire (1808–91), the founder of the Cavendish Laboratory at Cambridge, is buried at Edensor, on the borders of Chatsworth. Another Derbyshire man of science was John Woodward (1665–1728). No one seems to know his exact birthplace; but he began life as a linen draper, studied physic, in 1692 became a Gresham professor, and in 1695 published his "Essay towards a Natural History of the Earth", "an amazing record of observations, paving the way, as it did, to the knowledge that the structure of the earth's surface was of like kind all the world over". He and Dr. Mead were probably the only Fellows of the Royal Society to fight a duel; fortunately, little harm was done. Woodward left his collections to Cambridge, founded the Woodwardian professorship there, and was buried in the nave of Westminster Abbey.

THE DISCOVERY OF THE INFINITESIMAL CALCULUS*

By Prof. H. W. TURNBULL, F.R.S.

FORESHADOWINGS of the integral calculus occur in the discoveries made by Democritus (fifth century B.C.) and Archimedes (third century B.C.), the former finding the volumes of a pyramid and a cone, and the latter many areas, curved surfaces and volumes, including the area of a parabolic segment which he did in three ways: (1) by means of a series of inscribed triangles the areas of which were combined in a geometrical progression; (2) by means of finite parallel and rectilinear strips; and (3) by summing not strips but parallel lines. In cases (1) and (2), the method of exhaustions reduced the error between a curved figure and its rectilinear portions indefinitely by further subdivision; and this principle gave satisfactory demonstrations in such cases. But case (3), which was only brought to light by Heiberg as recently as 1906 in a manuscript entitled the "Method", is essentially the method of indivisibles, which certainly produced results but they had to be proved by the method of exhaustions. Archimedes started with the geometrical property that in modern notation gives the equation $ay = x(b-x)$ for a parabolic segment on a base b along the axis of x. He interpreted this as an equality between the moment of a length y, placed at a fixed distance a from a fulcrum on the axis of y, and that of a length $b-x$ at a distance x. But all these lengths that stand on the base b form the parabolic segment, while all the lengths $b-x$ form a triangle. Therefore, the moment of the segment when removed and concentrated at a fixed distance from the fulcrum balances that of the triangle: whence the area of the segment is deduced from the known properties of the centre of gravity of the triangle.

During the fourteenth century the theory of motion was actively discussed, particularly by Suiseth of Oxford, and Buridan and Oresme (1323–82) of Paris. Velocity, acceleration, density and intensity of illumination were reckoned not as qualities but as quantities, and were comprised under the 'latitude of forms'. Suiseth used the words 'fluxes' and 'fluens' of a variable quantity, while Oresme was the first to represent an instantaneous rate of change by a straight line; and with him we have the beginnings of velocity–time graphs and their like. He also made the fertile observation that near its maximum the ordinate of a semicircle changes very slightly.

When Napier (1550–1617) discovered logarithms, he introduced the idea of dividing a straight line into an indefinite number of parts which were in geometrical progression. Now Archimedes had in effect integrated x^2 as $\frac{1}{3}x^3$ in the second of his three methods by using the same width for each of the parallel strips: and this was applied by Cavalieri and others in the early seventeenth century to higher integral powers of x. But when the widths were taken to be in geometrical progression, two considerable new discoveries were made: one in 1647 by Gregoire de Saint Vincent, who found the area of a hyperbola, and integrated x^{-1} as $\log x$; and the other, about the same time and probably independently, by Fermat, who found the area of the curve $a^p y^q = b^q x^p$, which gave the integral of $x^{p/q}$ for positive rational exponent. This device had rendered the areas of successive parallelograms equal in one case and in geometrical progression in the other.

Meanwhile, the differential calculus was emerging gradually through the problems of maxima and minima and of drawing a tangent to a curve. Kepler (1571–1631), who found that the volume of a rectangular block inscribed in a given sphere was largest when it was cubical, had reached this result from studying a table of such volumes, which further disclosed the feature already noticed by Oresme, that the change in the variable was small near the maximum. Shortly afterwards, a great systematic advance towards the calculus was made by the Italian school under Galileo (1564–1642), Cavalieri (1598–1647) and Torricelli (1608–47) by combining the properties of motion with geometry, and by rediscovering and systematizing the Archimedian method of indivisibles. Thus Galileo introduced the idea of finding the tangential direction of a parabolic trajectory by attending to the horizontal and vertical components of velocity. This led Torricelli, his pupil, to apply the method to the curve $y = x^3$ and to that of $x^m y^n$ = constant. Also the "Geometria Indivisibilibus" of Cavalieri, which was begun in 1626 and published in 1635, exerted a widespread influence by its insistence upon matching the component indivisibles in two comparable figures. Despite its logical defect—for it, so to say, reaches as far as the

* Substance of a course of three lectures given at University College, University of London, on April 30, May 2 and May 4.

conception $\int y$ but omits from $\int y dx$ the crucial factor dx—it nevertheless proved a powerful and suggestive tool. Transmutation of figures became a ready way of discovering new and unexpected relations between curved figures, as when Cavalieri turned a spiral of Archimedes into a parabola with the same length of arc by straightening out the concentric circles of a polar co-ordinate system into parallel lines; or again when Torricelli matched the concentric cylindrical elements of a hyperbolic spindle with the cross-sections of a right circular cylinder, a result equivalent to integrating x^{-2} in finite terms from x to infinity.

Parallel with this influential advance was the work of Roberval (1602–75), whose contemporary "Traité des Indivisibles" lay unpublished until 1693. Roberval in turn probably influenced Pascal (1623–62), whose "Traité des sinus du quart de cercle" (1659) fired the imagination of Leibniz when he read it in 1673 and led him to think of the 'characteristic triangle', the sides of which were dx, dy and their hypotenuse. Pascal was here dealing with Archimedes's famous comparison between the superficial zone of a sphere and that of a circumscribing cylinder. Pascal moved away from a crude doctrine of indivisibles by attending to the elementary strip that gave part of the circular quadrant, and attained the equivalent of integrating $\sin\theta$ with regard to θ. It is surprising that he should have brought the problem of quadratures to the point where his diagram actually suggested how to deal with the problem of tangents, yet without taking the next and crucial step out of which the infinitesimal calculus emerges whole—of recognizing that integration and differentiation are converse operations.

Meanwhile, Fermat (1601–65), who with Descartes founded analytical geometry, had initiated (1629) the differential calculus by his algebraic treatment in determining the maximum of the product $x(a-x)$ where x may vary. He replaced x by $x + E$, equalized the new and old expressions, cancelled E, made x and $x + E$ coincide and deduced that $x = \frac{1}{2}a$. Though it was far from clear how to justify such a procedure that treated E at once as both non-zero and zero, the method was acclaimed and generally accepted: it spread to Italy and to the Low Countries through Hudde (1633–1704) and Sluse (1622–85) and, probably through Wallis, to England. Fermat also applied it with success to the problem of tangents. Wallis (1616–1703), who published his "Conics" in 1655 and his "Arithmetica Infinitorum" in the following year, made further essential advances by his careful treatment of the problem of tangents in the former and his arithmetical treatment of quadratures and infinite series in the latter. The significance of the one is seen in what Barrow made of it in his "Lectiones Geometricæ" (1670), and of the other in its influence upon Newton.

The time had now come for the discovery of the infinitesimal calculus in its full generality, and the credit for this belongs to Barrow (1630–77), Gregory (1638–75), Newton (1642–1727) and Leibniz (1646–1716). While each made characteristic original contributions, it is still an open question just how far each was influenced by another. Barrow's "Lectiones" were a systematic development of both the differential and the integral calculus, demonstrated entirely in geometrical form and shown to be mutually converse processes by means of the fundamental theorem, which is explicitly proved, and which enlightens the whole theory. Barrow performed all the ordinary processes of differentiation, and changed the variable and also interchanged the variables in an integral, where he acknowledged the work of Gregory. At the advice of a friend (who was Newton) he included algebraic rules, that are evidently based on Fermat's method, which he had used for the purpose of attaining many of his results, just as Archimedes had used his "Method"; but the chief concern was the geometrical demonstration.

Both Newton and Gregory admitted an indebtedness to Fermat in respect to the algebraic manner of deriving a tangent. Curiously enough, each of them independently replaced Fermat's symbol E for the increment of x by a small letter o, a notation which is suggestive of, but differing from, an absolute zero. This symbol appeared in the "Geometriæ Pars Universalis" (1668), a work of great breadth wherein Gregory consciously brought the many recent discoveries in geometry into one view. It contains the earliest published form of the fundamental theorem of the calculus by solving the problem of finding the curve having given the formula for its arc, and conversely. Within the next four years Gregory developed his "several universal methods yet unheard of in mathematics", by applying the operations of differentiation and of integration to factorial series and to power series, this last being suggested by Mercator's series for $\log(1 + x)$ in 1668, and by hints of what Newton was achieving. Gregory's expansion in 1672 of y in powers of x when $y = 1 - \cos\theta$ and $x = \theta + \sin\theta$ involved eight successive differentiations of y with regard to x. He prepared a memoir for publication but withheld it on hearing that Newton had anticipated him.

To Newton above all belongs the title of first inventor of the calculus, a subject which he named 'Fluxions', in that he had learnt or had discovered all the properties hitherto mentioned and many more (with the probable exception of the expansion by successive differentiation) within his early post-graduate years, 1664–66; but what is more important, he welded these scattered geometrical and kinematical results into a systematic analytical form. The "De Analysi" (1669), which was lent to Barrow and other friends, exhibited a breadth and incisiveness that put it in a class apart. Yet it omitted much of what Newton already knew, as, for example, "The invention of Theorems for finding the crookedness of lines", a typical but unpublished manuscript, dated May 1665. In it by quick gradations from the simple form $ay = xx$ to the general implicit equation (written $\mathcal{X} = 0$) for a curve, Newton investigated the centre and the radius of curvature, ending with formulæ that involved the five first and second partial derivatives of $\mathcal{X}$ with respect to x and y. Dots placed right and left of the symbol indicated the various derivatives. No distinct account of what Newton had achieved by his method of fluxions was published until 1693 and then only in part, which is unfortunate in view of the controversy with Leibniz over the priority of invention.

Leibniz's mastery of the differential and integral calculus was almost as rapid as Newton's. It began in 1673 and culminated in November 1676 when he gave the fundamental relation between these correlative operations in his own original and characteristic notation of differentials dx, dy and integrals $\int y dx$. In 1677 he formulated the rules for differ-

entiating sums, products, quotients, etc., of y, z, u, v in terms of dy, dz, du, dv. Leibniz held that his method was distinct from, and independent of, Newton's, and that it proceeded not by fluxions of lines but by the differences of numbers. His dx, dy, d^2x, etc., were infinitesimal differences which he called, with assurance, functions of x, and with which he freely worked. He even alluded to fractional powers of the operator d. The suddenness of its advent and the permanence of its use measure the value to mathematical thought of this notation of Leibniz. The corresponding notation of Newton was o or else $\dot{x}o$ for dx, $\dot{y}o$ for dy and $\dot{y}/\dot{x}$ for dy/dx. Commenting on this in 1712 or thereabout, Newton remarked: "The quantity o is supposed to be either finite or infinitely small and vanishes in finite computations. The former case forms the method of prime and ultimate ratios, the latter the method of moments; each the method of fluxions. The former method is geometrical and completely demonstrative, the latter is expedite but is set up by principles which are not yet demonstrated."

NEWS and VIEWS

Agriculture in West Africa: Prof. John Phillips

Prof. John Phillips, formerly professor of botany and in charge of soil conservation and pasture management research in the University of the Witwatersrand, Johannesburg, and more recently chief agricultural adviser to the Overseas Food Corporation, has by agreement relinquished this post owing to the reduction in scope of the groundnuts scheme in Tanganyika. Prof. Phillips has now accepted a post in the University College of the Gold Coast, Achimota, Accra, where he will build up a faculty of agriculture. The project, which is to be financed by University College and other funds, aims at the establishment of a faculty capable of giving university instruction in agriculture and related subjects, at training senior students in research methods and at making a contribution toward the solution of technical problems in the general field of agriculture. It is expected that the faculty will work in the closest co-operation with the government departments of agriculture and forestry and such other official or quasi-official organizations as are concerned with agriculture or agricultural research in one form or another in the Colony. The syllabuses will be arranged, as for other subjects, in collaboration with the University of London, and the standard of the B.Sc. and higher degrees in agriculture to be awarded by the College will be in accordance with the requirements of that University. Prof. Phillips will be responsible for the organization of the faculty of agriculture from its inception. The new faculty will be financed in part from funds derived from a levy on cocoa production in the Gold Coast.

Toxic Chemicals used in Agriculture

The Working Party on Precautionary Measures against Toxic Chemicals used in Agriculture, which has recently issued its first report (H.M. Stationery Office. S.O. Code No. 24–190), has been asked by the Ministry of Agriculture and Fisheries, the Ministry of Health, the Ministry of Food and the Department of Health for Scotland to inquire whether any risks arise, from the point of view of the consumer of the final product, in the use of toxic chemicals in agriculture and in the storage of food, and to make recommendations for protective measures should these appear to be desirable. The membership of the Working Party is as follows: Prof. S. Zuckerman (chairman), Dr. J. M. Barnes, Dr. R. H. Barrett, Mr. A. B. Bartlett, Mr. P. N. R. Butcher, Mr. W. Morley Davies, Mr. N. R. C. Dockeray, Dr. R. A. E. Galley, Mr. R. F. Giles, Mr. C. T. Gimingham, Mr. A. Holness, Dr. B. S. Lush, Mr. J. R. McCallum, Dr. R. J. Peters, Dr. H. V. Taylor, Mr. H. Cole Tinsley, with Mr. K. R. Allen and Mr. W. K. Melrose as joint secretaries. These members represent, in addition to the departments concerned, the Medical Research Council, the Agricultural Research Council and the Agricultural Improvement Council. Organizations wishing to submit written evidence to the Working Party should write to Mr. W. K. Melrose, Ministry of Food, Portman Court, London, W.1.

Medical Mycology

The increasing importance in the United States of human diseases caused by fungi impelled the New York Academy of Sciences to call a conference on the subject in 1947. Papers read at this gathering, under the chairmanship of Frederick Reiss, have now been published (*Ann. N.Y. Acad. Sci.*, **50**, Art. 10, 1209; Sept. 6, 1950; no price). While the sixteen papers of the report contain the results of much original work, perhaps their greatest collective value lies in their provision of an adequate summary of recent knowledge in medical mycology. Mycoses such as ringworm on school children, and 'athlete's foot' in the Armed Forces, are fairly widespread in some parts of the United States. The conference also served to indicate the more urgent lines of future research. Mycological nomenclature demands simplification (though contributions in this direction have been made since 1947). The implications of possible immunological reactions are as yet but little explored, and relatively little is known about the mode of transmission of superficial mycoses. Though penicillin is valuable in the treatment of actinomycosis, and fatty acids can be used against certain other fungal diseases on some patients, there is still a pressing need for more investigation of the all-important question of control.

International Commission on Glass

The annual meeting of the International Commission on Glass was held in the buildings of the Institut du Verre in Paris during June 5–9, under the presidency of Prof. W. E. S. Turner. Two additional organizations were admitted to the Commission, namely, the Nordiska Glastekniska Föreningen and the Japanese Ceramic Association. The former is a newly constituted international society for the study of glass science and technology, and embraces Sweden, Denmark, Finland and Norway; its representatives, elected to membership by the Commission, were S. Lindroth (president), F. Gjesmo (Norway) and H. Söderström (Finland). The elected representatives of the Japanese Ceramic Association were Prof. I. Sawai and T. Moriya, and with Dr. N. Nakamura as president. The number of members of the Commission is now thirty-six. Two days of the meeting were devoted to symposia, the first dealing

with fundamental definitions and standards in glass technology, and the other with physical methods for the control of the quality of glass during manufacture. Visits to the extensive new research laboratories of the Compagnie de St. Gobain and to the optical glassworks of Parra-Mantois at Le Vesinet followed the meeting.

Roland Eötvös Physical Society of Hungary

During May 27–29 the Roland Eötvös Physical Society of Hungary, with the support of the Hungarian Academy of Science, held its first local convention in Pécs. Thirty-two lectures were given on the quantum theory of fields, on the experimental methods of nuclear physics, and on the physics of solids. The opening lecture was delivered by Prof. L. Jánossy, who discussed an experiment of forty years ago by Prof. Paul Selényi, in which the interference of rays emitted by a light source in widely diverging directions was demonstrated for the first time (*Ann. d. Phys.*, 35, 444 (1911); *Z. Phys.*, 108, 401 (1938), and 111, 791 (1939); *Phys. Rev.*, 56, 477 (1939)). The lecture was followed by a demonstration of the experiment. At the conclusion of the meeting Prof. S. Kovács gave a report on the activities of the Central Physical Institute of the Academy of Science, under his direction, and on the progress of its new home, which is nearing completion.

Gramophone Driven by a Hot-air Engine

In the December 1950 issue of the *Museums Journal*, Dr. Stuart M. K. Henderson describes a gramophone of unusual type recently acquired by the Museum at Glasgow. Apparently it is of normal, early twentieth-century construction; the horn, sound box, cabinet and turntable are typical of designs about 1908. The drive, however, is by means of a motor based on the principle of the hot-air engine. It seems clear that it has been constructed from standard gramophone parts with an air-engine inserted in place of the normal motor. The heat is obtained from a methylated spirit burner placed under a cylinder below a mica box. In his article Dr. Henderson gives full details of the construction. He is anxious to hear of any other examples.

Canadian Society of Microbiologists

Some 175 microbiologists from eight provinces of Canada met at the University of Ottawa during June 7–8 and formed a Canadian Society of Microbiologists (Société Canadienne des Microbiologistes). Officers of the new Society are: *President*, Dr. R. G. E. Murray, Department of Bacteriology and Immunology, Faculty of Medicine, University of Western Ontario; *Vice-Presidents*, Dr. Maurice Panisset, Institut de Microbiologie et d'Hygiène, Université de Montreal, and Dr. A. G. Lochhead, Science Service, Department of Agriculture, Ottawa; and *Secretary-Treasurer*, Dr. N. E. Gibbons, Division of Applied Biology, National Research Council, Ottawa. A Council was also elected, the members representing as many fields of microbiology and regions of Canada as possible. Twenty-five papers dealing with general, agricultural, industrial and medical microbiology were presented at this inaugural meeting.

Freedom and Responsibility: Conference at Oxford

The organization known as the Present Question Conference, which was founded in 1945, is an independent non-profit-making association of men and women in all walks of life which seeks to reaffirm the importance of human values and relationships amid the growing impersonalism and materialism that tend to characterize life to-day. The Conference works along three lines: small groups, which meet regularly throughout the year; major conferences; and publication of the journal *Question*. The conference this year, to be held at Lady Margaret Hall, Oxford, during August 4–11, will be on "Freedom and Responsibility". Each day of the conference will consist of lectures, study groups and discussion devoted to a particular aspect of the general theme, and on August 9 Sir John Cockcroft and Dr. J. Bronowski will be the two speakers, under the chairmanship of Prof. F. E. Simon, their subjects being "Pure Science" and "Applied Science", respectively. The fee for the conference is 21*s.* (students 15*s.*) and accommodation is available at Lady Margaret Hall. The journal *Question* is issued three times a year (7*s.* 6*d.* a volume, or 2*s.* 6*d.* each issue, plus postage). All inquiries relating to the Present Question Conference should be addressed to the secretariat at 37 Middleway, London, N.W.11.

Courses on Rural Studies

The Association of Agriculture, in co-operation with a number of local bodies, is arranging several courses of study during the summer. The subjects covered include: rural sociology (at Barford, Warwick); man and the land (at Perth); the content and teaching of rural science (at Trinity College, Carmarthen); biology and agriculture (at Harper Adams Agricultural College, Shropshire); man and his food (at Shuttleworth College, Biggleswade); and biology and social studies (at the Cumberland and Westmorland Counties' Farm School, Penrith). Particulars can be obtained from the General Secretary, Association of Agriculture, 238–240 Abbey House, 2 Victoria Street, London, S.W.1.

University of Birmingham

Prof. P. B. Medawar has resigned from the Mason chair of zoology in the University of Birmingham on being appointed Jodrell professor of zoology and comparative anatomy in University College, London. The following resignations from Birmingham have also been announced: H. McManus, lecturer in mathematical physics, on appointment as research officer at the Canadian Atomic Energy Project, Chalk River, Ontario; S. J. Green, lecturer in chemical engineering, on taking up a senior appointment with Glaxo Laboratories, Ltd.; F. E. Kras, lecturer in mechanical engineering; M. J. Wise, lecturer in geography, on appointment as lecturer in geography in the London School of Economics. The following appointments have recently been made in the University: B. Mills, lecturer in mechanical engineering; Dr. R. W. Cahn, lecturer in metallurgy; Dr. P. T. Matthews, Imperial Chemical Industries fellow in mathematical physics; Dr. K. F. Chackett, Imperial Chemical Industries fellow in physics. The second chair of physics in the University has been named the Oliver Lodge chair of physics, to commemorate the work in physics done by Sir Oliver Lodge, first principal of the University. An annual lectureship, to be called the S. J. Ellis Memorial Lectureship, has been endowed at the Department of Mechanical Engineering by funds subscribed by past and present members of the Department.

Geological Society: Officers

The following have been elected officers for the ensuing year of the Geological Society: *President*, Dr. G. M. Lees; *Vice-Presidents*, Prof. O. T. Jones, Dr. W. Campbell Smith, Dr. C. J. Stubblefield, Prof. D. Williams; *Secretaries*, Prof. S. E. Hollingworth, A. J. Butler; *Foreign Secretary*, Prof. O. T. Jones; *Treasurer*, P. Evans

American Society of Biological Chemists: Officers

The following have been elected officers of the American Society of Biological Chemists for the year 1951–52: *President*, Dr. Vincent duVigneaud; *Vice-President*, Dr. H. A. Mattill; *Secretary*, Dr. Elmer H. Stotz (Biochemistry Department, University of Rochester School of Medicine and Dentistry, Rochester 20, N.Y.); *Treasurer*, Dr. P. P. Cohen; *Councillors*, Dr. H. T. Clarke, Dr. C. F. Cori and Dr. W. M. Stanley.

The Night Sky in July

New moon occurs on July 4d. 07h. 48m., U.T., and full moon on July 18d. 19h. 17m. The following conjunctions with the moon take place: July 3d. 08h., Mars 4° S.; July 5d. 08h., Mercury 2° S.; July 8d. 08h., Venus 0·6° S.; July 10d. 16h., Saturn 4° N.; and July 24d. 12h., Jupiter 5° S. In addition to these conjunctions with the moon, Venus is in conjunction with Regulus on July 7d. 04h., Venus being 0·1° N., and Mercury is in conjunction with Regulus on July 27d. 03h., Mercury being 0·6° S. Mercury is an evening star but sets too soon after the sun in the early portion of the month to be seen; on July 15 and 31 it sets at 21h. 15m. and 20h. 40m., respectively, and may just be seen after sunset. Venus is an evening star, setting at 22h. 40m., 21h. 45m. and 20h. 45m., at the beginning, middle and end of the month, respectively, during which time the visible portion of the illuminated disk decreases from about 0·45 to 0·26; but there is a slight increase in brightness owing to the planet approaching nearer to the earth by nearly twenty million miles. Mars, a morning star, rises a little before 3h. during July, but in the earlier part of the month its rising is rather too close to that of the sun for favourable observation. Jupiter rises at midnight on July 1, and at 23h. and 22h. on July 15 and 31, respectively, and can be observed a little south of δ and ϵ Piscium. Saturn sets at 23h. 30m., 22h. 40m. and 21h. 35m. at the beginning, middle and end of the month, respectively, and is visible in the constellation Virgo, forming a triangle with the stars β and η Virginis, Saturn being north of the stars. Occultations of stars brighter than magnitude 6 are as follows: July 15d. 20h. 42·5m., τ Scor. (*R*); July 20d. 23h. 41·0m., ι Aquar. (*D*); July 21d. 0h. 50·1m., ι Aquar. (*R*); and July 27d. 01h. 34·3m., ϵ Arie. m (*R*). *D* and *R* refer to disappearance and reappearance, respectively, and the times to observations made at Greenwich. The earth reaches aphelion on July 4.

Announcements

The Joule Museum at Salford will be opened by Alderman J. Brentnall, chairman of the Education Committee of Salford, on July 3. The opening ceremony will be preceded by a reception at the University of Manchester with an address on "Joule's Scientific Outlook" by Prof. L. Rosenfeld, professor of theoretical physics in the University.

Sir Henry Tizard, chairman of the Advisory Council on Scientific Policy, is to open the new research and development buildings of the Simon Engineering Group at Cheadle Heath, Stockport, on July 3.

Mr. R. S. Leigh has been elected to a Beit Fellowship for Scientific Research of the value of £500 per annum, tenable at the Imperial College of Science and Technology, for research on the elastic properties of metals and alloys.

The *Review of Coal Tar Technology* for January–June 1950 (issued by the Coal Tar Research Association, Oxford Road, Gomersall, near Leeds; pp. 72; 1951; 5*s*.) contains brief abstracts of publications and patents dealing with all aspects of coal tar technology, classified under appropriate headings, and is likely to be of interest to many scientific workers outside the industry.

The Faraday Society is organizing a general discussion, open to all, on the "Size and Shape Factor in Colloidal Systems", to be held at Ashorne Hill, Leamington Spa, during July 18–20. There will be four sessions: classical colloids (theory of size distribution, paints, coals and greases, etc.), colloidal and polyelectrolytes (micelle and swollen micelle), fibrous macromolecular systems (cellulose and muscle) and viruses. Accommodation is available at Ashorne Hill. The fee for the conference is £1 (members 5*s*.), and applications must be sent, before July 4, to the assistant secretary of the Faraday Society at 6 Gray's Inn Square, London, W.C.1.

A summer school in programme design for automatic digital computing machines, on the lines of the one held last year, will be given in the University Mathematical Laboratory, Cambridge, during September 11–21, 1951. The course will give a basic training in the mathematical use of machines, dealing with the processes employed and their embodiment in programmes which specify the operation in detail. Lectures and practical classes will be held in the design of programmes for the Laboratory's electronic delay storage automatic calculator. Application forms, to be completed by July 14, can be obtained from G. F. Hickson, secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge.

The Cambridge Branch of the Association of Scientific Workers is to arrange a conference on "Ethical Problems of the Scientific Worker", which will be held in Cambridge during July 28–29. Among the speakers will be Lord Haden Guest, president of the Association, Prof. N. F. Mott and Dr. John Hammond. Further particulars can be obtained from the Conference Secretary, Cambridge Branch, Association of Scientific Workers, 27 Bateman Street, Cambridge.

The second conference of the International Union of Leather Chemists' Societies will be held at the Portland Hall Annexe of the Regent Street Polytechnic, London, W.1, during September 9–14, under the presidency of J. R. Blockey. The Society of Leather Trades' Chemists is the host society. During the conference, four sessions will be devoted to the reading of papers, and in addition a number of social events and excursions have been arranged. Forms of registration for the conference, to be completed by August 10, can be obtained from G. H. W. Humphreys, Forestal Central Laboratories, Harpenden Rise, Harpenden, Herts.

NEW X-RAY EVIDENCE ON THE CONFIGURATION OF POLYPEPTIDE CHAINS

Polypeptide Chains in Poly-γ-benzyl-L-glutamate, Keratin and Hæmoglobin

POLYPEPTIDE chains in certain synthetic polymers, in fibrous proteins of the keratin–myosin–fibrinogen group, and also in hæmoglobin, appear to be coiled or folded to about half the length of a fully stretched chain. Many different chain configurations have been proposed to account for the X-ray diffraction data[1], the latest being those of Pauling, Corey and Branson[2]. Until now, however, the lack of any simple and decisive criterion in the X-ray diffraction pattern has made it difficult to test the validity of proposed models. This communication describes a new reflexion, not hitherto observed, which is given by the proteins mentioned above. The spacing at which this reflexion appears excludes all models except the 3·7 residue helix of Pauling, Corey and Branson, with which it is in perfect concord.

This model has two types of repeat: (*a*) the distance between successive turns of the spiral (5·55 A.), and (*b*) the spacing along the chain of successive amino-acid residues (1·5 A.). Thus there are in this model 3·7 residues per turn. Pauling and Corey[3] quote a calculation by V. Shoemaker showing that the 5·1-A. reflexion can be explained by the turn of the spiral. I have found a new reflexion from planes perpendicular to the fibre axis at a spacing of 1·50 A. which corresponds to the repeat of the amino-acid residues along the chain. This reflexion was discovered by oscillating the specimens about a direction normal to the fibre axis, so as to satisfy Bragg angles for planes perpendicular to that axis, and by taking photographs on cylindrical films of 3-cm. radius instead of the flat plates normally used.

Structure proposed by	Illustration	Repeat of pattern	Screw axis	Spacing of first 0*k*0 reflexion
Ambrose, Elliott and Temple (ref. 4)	Fig. 6, ref. 1	5·0–5·6	2	2·5–2·8
Bragg, Kendrew and Perutz (ref. 1)	Fig. 10, ref. 1	5·4	3	1·8
Huggins (ref. 5)	Fig. 11, ref. 1	5·2	3	1·7
Bragg, Kendrew and Perutz (ref. 1)	Fig. 12, ref. 1	5·6	4	1·4
Astbury and Bell (ref. 6)	Fig. 8, ref. 1	10·2	2	5·1; 1·7
Pauling, Corey and Branson	Fig. 2, ref. 2	*X* × 1·5	–	1·5

The appearance of a 1·50-A. reflexion from planes perpendicular to the fibre axis is incompatible with any other model so far proposed, for the following reason. All these models possess screw axes of symmetry. Thus if the chain axis *Y* is an *n*-fold screw, 0*k*0 should be absent for $k = nm$, where m is any integer. The first 0*k*0 reflexion should occur at a spacing of $d = b/n$, where b is the repeat of pattern along the chain. The table lists the structures so far proposed, together with their repeat distances, their types of screw axes and the spacing of the first 0*k*0 reflexion to be expected. It is seen that the only structure to give a 1·5-A. reflexion is that of Pauling, Corey and Branson; the one that comes closest to it (1·4 A.) is a topographically similar model with a fourfold screw axis proposed by Bragg, Kendrew and Perutz.

Bamford, Hanby and Happey[7] attempted to interpret their X-ray photograph of poly-γ-benzyl-L-glutamate in terms of a structure possessing a repeat of 5·0–5·6 A. and a screw dyad, which should give a strong reflexion at 2·5–2·8 A. Oscillation photographs of an oriented film of the polymer, kindly lent to me by Dr. A. Elliott, were taken about the normal to the fibre axis, but showed no such reflexion. On the other hand, an extremely powerful reflexion was discovered at a spacing of 1·50 A. (Fig. 1), in agreement with the structure postulated by Pauling and Corey[2]. The presence of this reflexion does not in itself prove the correctness of Pauling and Corey's structure, but taken in conjunction with the favourable agreement of observed and calculated intensities of other reflexions already obtained by these authors, it leaves little doubt about their structure being right.

The reflexion at 1·50 A. was also discovered on oscillation photographs of horse hair and of porcupine quill tip. (It is actually listed as one of the meridional reflexions of porcupine quill tip by MacArthur[8], but its significance does not seem to have been realized.) Fig. 2 is a Geiger counter spectrometer record of horse hair kindly placed at my disposal by Mr. Andrew Lang, which shows the relative intensities of the 5·1-A. and the 1·5-A. reflexions. When hair is stretched to the β-form the 1·5-A. reflexion vanishes.

Pauling and Corey also propose a structure of feather rachis keratin[10]. So far as can be seen from their illustration, this consists to about three-quarters of its volume of 3·7 residue helices, the remaining quarter being made up of 'pleated sheets' of extended chains. If this structure were correct, feather rachis keratin should show the 1·5-A. reflexion. Prolonged exposure of seagull's feather rachis set at the appro-

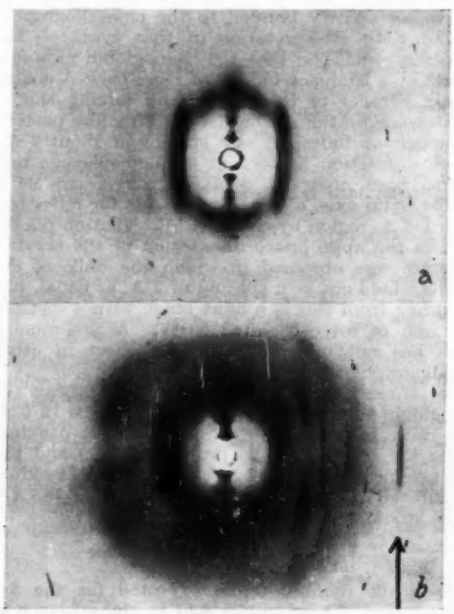

Fig. 1. X-ray photographs of poly-γ-benzyl-L-glutamate. (*a*) Conventional picture with fibre axis horizontal and normal to X-ray beam. (*b*) Fibre axis oscillated between angles of 55° and 85° from X-ray beam. Arrow indicates 1·50-A. reflexion. 3-cm. cylindrical camera, copper *K*α radiation

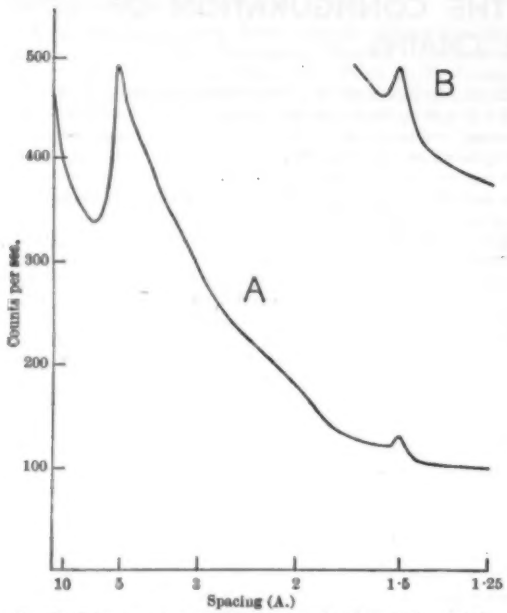

Fig. 2. Geiger counter spectrometer record of horse hair rotated about a normal to the fibre axis. (*A*) Bragg angle for 0*k*0 planes $2\theta = 7°–75°$, taken with reduced aperture of beam. (*B*) Repeat of $2\theta = 55°–75°$ with full aperture of beam

priate Bragg angle revealed no trace of such a reflexion, which shows that the structure proposed by Pauling and Corey must be wrong.

The three-dimensional Patterson synthesis of horse methæmoglobin shows rod-like concentrations of high vector density parallel to the crystallographic *X*-axis[11]. My interpretation of that synthesis led me to the conclusion that the hæmoglobin molecule consists of a compact bundle of close-packed chains running parallel to the *X*-axis and having the α-keratin configuration. The X-ray diffraction pattern of hæmoglobin fades out at a spacing of about 2 A., and no diffraction pattern at smaller spacings had hitherto been observed. Taking the *X*-axis as a possible chain axis, a search was made for reflexions in the 1·5-A. region by taking a 5° oscillation photograph in the appropriate orientation of the crystal. A picture was obtained in which the bulk of the reflexions fade out at a spacing of 2 A. as usual, but protruding from this is a faint bulge with a distinct maximum of intensity at 1·50 A. A preliminary search has not revealed any such effect in other crystallographic directions.

The three-dimensional Patterson synthesis of hæmoglobin shows neighbouring chains to be 10·5 A. apart and arranged in cylindrical close-packing. Taking the density of the protein as 1·30 and the mean residue weight as 112·5 [11], the number of residues in a 'sub-cell', $10·5 \times 10·5 \times 1·5 \times \sin 60° = 143$ A.^{3}, can be calculated:

$$\frac{143 \times 1·3 \times N}{112·5} = 1·00 \text{ residue},$$

which is the number to be expected for the 3·7 residue helix. These results add to the evidence in favour of the hæmoglobin structure proposed by me[11] and indicate that the chains are coiled to form 3·7 residue helices in poly-γ-benzyl-L-glutamate, in α-keratin and in hæmoglobin.

The discovery of the 1·5-A. reflexion shows that even relatively disordered substances like hair may contain an atomic pattern of such high intrinsic regularity that it gives rise to X-ray diffraction effects at spacings where they had never before been suspected.

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Polypeptide Chains in Frog Sartorius Muscle

Oscillation photographs of dried frog sartorius muscle were taken about a direction normal to the fibre axis using a 3-cm. cylindrical camera and copper radiation. The specimens included muscle dried in the stretched, relaxed and contracted state (contraction by electrical stimulus). All photographs show the 1·5-A. reflexion from planes normal to the fibre axis, as described in the preceding communication. The reflexion is most intense on photographs of stretched muscle, slightly weaker on pictures of relaxed muscle, and very faint on photographs of contracted muscle. Thus both stretched and relaxed muscle seem to contain polypeptide chains coiled in the 3·7 residue helix and running parallel to the fibre axis. It is too early to say whether the weakening of the 1·5-A. reflexion on contraction is due to a change in chain configuration or to the disorientation of larger units. In any event, clear evidence on the mechanism of contraction cannot be expected unless X-ray photographs are taken during an actual twitch. In addition to the 1·5-A. reflexion, which can be recognized as an 0*k*0 reflexion by its small angular spread, the photographs also show a wide arc at 2·9–3·0 A. which is about as intense as the 5·1-A. reflexion. This arc is strongest in stretched and weakest in contracted muscle, and was also observed in oscillation photographs of hair.

Our results are incompatible with the mechanism of muscle contraction proposed by Pauling and Corey[1], who suggest that the chains in extended muscle are almost fully stretched, and that they coil up to form 3·7 residue helixes on contraction. On the other hand, our findings are in accord with those of Astbury and Dickinson[2], who showed both extended and relaxed muscle to have the α-keratin structure which becomes disorientated on contraction.

We are grateful to the Medical Research Council for financing the work described above.

H. E. Huxley
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SUBSTITUTION PRODUCTS OF TROPOLONE AND ALLIED COMPOUNDS

By Prof. TETSUO NOZOE
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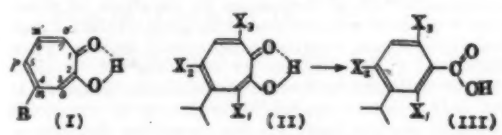
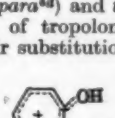
SINCE compounds having a tropolone nucleus (I, $R = H$), as initially proposed by Dewar[1], have been successively found in Nature[2,3] and have also been obtained by synthesis[4–7], interest has centred on the aromaticity of these peculiar, unsaturated, seven-membered ring compounds. However, reports on the substitution products of tropolone and its derivatives (hereafter termed 'tropoloids'[8] for the sake of convenience) have been limited to a mere mention of crystalline bromo[9] or azo compounds[8a,4a,7b], so far as I know, and no reference has been found to systematic studies on the substitution reactions of tropoloids in other laboratories; though recently Haworth[7c] obtained tropolone aldehyde and carboxylic acid by the oxidation of β- (that is, *m*-) methyl tropolone, and Bartels-Keith and Johnson (*Chem. and Indust.*, 602, 1950) reported on the synthesis of carbethoxy-tropolone. The present article gives a general survey of our work in this field.

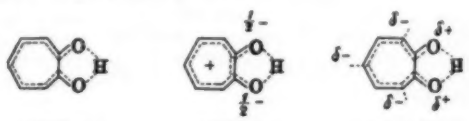
My co-workers and I have carried out extensive studies on the substitution reactions of hinokitiol (I, R = ś-C_3H_7)[8], that is, Erdtman's β-thujaplicin[3], for the past few years. As a result, about a hundred substitution products have been obtained and studied, including halogeno[10a], nitro[10b], nitroso[10f], azo[10c], and sulphonic acid derivatives[10d], as well as amino[10e] and hydroxy compounds[10f]. The chemical structures of the majority of these compounds have been confirmed by the use of various organic chemical methods, such as consideration of the course of their formation, diazo-coupling[10g], sulphonation[10a,10d], and especially the structural determination of *m*-cumic acid derivatives (III) obtained by rearrangement[11a], together with such physical methods as the measurement of dipole moments[12] and infra-red absorption spectra[13a].



We have also succeeded in synthesizing tropolone (I, $R = H$)[5], the mother substance of these series, quite independently of other laboratories[7], and at about the same time. Moreover, we have synthesized methyl (*meta* and *para*)[6a], ethyl (*meta*)[6a], *iso*propyl (*ortho*[6b], *meta*[6c] and *para*[6d]) and *tert.*-butyl (*meta* and *para*)[6d] homologues of tropolone, and carried out experiments on their substitution reactions[6,14].



In order to explain the unique characteristics of tropoloids[8]—their remarkable stability in spite of the unsaturated, seven-membered ring structure, high susceptibility to electrophilic reagents, fair amount of acidity though forming a conjugate acid cation (IV) in the presence of strong acids, high tendency towards complex salt formation, the large polarizability, etc.—I[8] have assumed also resonance between the many ionic and non-ionic structures accompanied by the formation of a hydrogen bond, and have classified these into three types (*A*, *B* and *C*) which may conveniently be shown by the following representative formulæ:

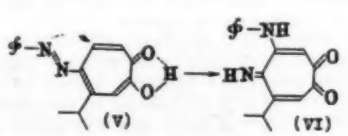


Based on the measurements of dipole moments[12a] and magnetic susceptibilities[12b], type *B* was found to be making the chief contribution in a normal state[8b]. As was made clear by the consideration of the resonance structure (type *C*)[8b] and calculation of the π-electron density by molecular orbital treatment[12b,15], the positions of the tropolone nucleus most susceptible to electrophilic substitution should be *o*, *p* and *o'*[8a,15] (3, 5 and 7). Our experimental results entirely support this conclusion.

However, the substitution of hinokitiol is far more complicated, due to the steric hindrance and inductive effect of the *iso*propyl group in its *meta* position. The nature of the substitution products and their yields vary greatly according to the kinds of solvents used, the presence or absence of catalysts, as well as the temperature and other conditions of reaction[8b]. Quite recently, Dewar[15] predicted that electrophilic substitution would occur solely in the *para* position of tropolone; but the actual reactions are not so simple[8b].

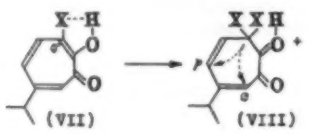
In tropolone and its homologues, the azo group most easily enters in the *para* position[10c,11], and when this position is already occupied by alkyl[6d] or halogen[10f,14a] or a sulphonic acid group[14b], the coupling scarcely takes place; or if it does, it is wholly different from the usual manner and is fairly difficult to handle.

The most interesting of the azo compounds is (V), from hinokitiol. By heating (V) with glacial acetic acid or ethanol, or by simply heating (V) above its melting point, it becomes what may be termed 'hinopurpurin'[8,10c], a compound assumed to possess an unsaturated, seven-membered ring quinonoid



structure (VI) (hereafter designated as the 'tropoquinonoid'[3a]). This rearrangement does not occur at all in the case of the azo compounds of tropolone[5] or its methyl[3a], ethyl[3a] or *ortho*-*iso*propyl[14a] homologues. We assumed that this rearrangement is due to the specific steric influence of the *iso*propyl group in the *meta* position of hinokitiol[4b]. *m*-*tert*.-Butyltropolone does not react with a diazonium salt[4d].

If instead of the fully ionic reagent such as the above-mentioned diazonium salt, one uses non-ionic or almost non-ionic reagents such as halogen or nitric acid, then the initial substitution takes place, not in the *para* but in the two *ortho* positions[3b] (though a chlorine atom has a tendency to enter to some extent also into the *para* position[10a]). This is assumed to be due to the activation of the reagents by the hydrogen bonding (*ortho* effect) with the hydroxyl group of the tropoloid nucleus[4b].



However, the situation becomes entirely different in the case of a second substitution. When there is an electro-negative group (*X*) in the *ortho* or *ortho'* position, a hydrogen-bonding of type (VII) also becomes possible, and the second group may then enter the *para* position by a secondary intramolecular rearrangement via an intermediate (VIII) of a tropoquinonoid structure[4b]. Due to the steric hindrance, *o*,*p*- (3, 5) disubstitution products (II : X_2 = H) become more difficult, or almost impossible, to form than trisubstituted products (II)[4b,16a].

Since there is no steric hindrance in the case of tropolone (I, *R* = H), it easily gives trihalogen compounds in ionic media; but in non-ionic media it gives a crystalline molecular compound of a special structure, or a crystalline oxonium (conjugate acid) salt[14d]. Nitration with nitric acid in glacial acetic acid yields *ortho*-mononitro-tropolone as well as polynitro-tropolones[14a], while nitrosation of tropolone with sodium nitrite and acetic acid gives *p*-nitroso tropolone[14e].

Generally, tropoloids cannot be sulphonated by concentrated or fuming sulphuric acid because they take the form of the conjugate acid cation (IV) and become resistant to cationoid reagents[4b]. They can easily be sulphonated, however, by heating with sulphamic acid. In the case of tropolone itself, the sulphonic acid group enters into its *para* position[14b], and only attacks the *ortho* position when the *para* is blocked by alkyl[3d] or bromine[14b]. By contrast, the sulphonic acid group enters only into the *ortho'* (7) position of hinokitiol (I, *R* = *i*-C_3H_7) even though the *para* position is vacant[10d], whereas the azo group enters easily into its *para* position only, as described above. Sulphonation is quite difficult in the case of α-thujaplicin, that is, the *o*-*iso*propyl isomer of hinokitiol, although both *para* and *ortho* position are unoccupied[14b]. This must be one of the unique features of the tropoloid system.

In the case of α-thujaplicin, a new tautomer of melting point 25·5° has been recently obtained[14b] besides the compound hitherto known of melting point 34°[3a,4b]. This is of interest in connexion with the fact that when a large and flat group such as nitro enters into a position where there is considerable steric interference, such as the *ortho* (3) position of hinokitiol, invariably two stable stereoisomers (kinds of tautomers) are formed[4b,14b]. It can be assumed that, since there already exists a certain amount of ring strain[4b] in the tropolone nucleus, and because the range of influence of each ring carbon atom in a heptagon is narrower than those in a hexagon, the coplanar tropolone nucleus becomes distorted by the steric interference of atoms or groups coming into its proximity. Then, as a result of the loss of coplanarity of the tropolone nucleus, a fairly large change may be brought about in the conjugate system of its π-electrons, so that quite different chemical and physical characteristics might become possible.

In the study of such a unique system, hitherto unknown, present in these tropoloids, it is not enough to rely solely on the routine methods of organic chemistry[4b]. One must expect full co-operation from the field of physical chemistry; only thus can we expect the newer and wider domain in tropoloid chemistry to be opened before us[4b].

Compounds of the tropolone series, in spite of the unsaturated, seven-membered ring structure, are very stable in general. However, when they are heated with highly concentrated alkalis, they undergo benzilic acid rearrangements to give benzene carboxylic acids, although the ease or difficulty of such rearrangement differs with each compound.

According to our experiments, hinokitiol (I, *R* = *i*-C_3H_7) is almost unaffected by being heated with alkalis at 250–300° for 30 min.[4a], whereas *o*- or *p*-nitrohinokitiol undergoes rearrangement on being heated for 10 min. with concentrated potassium hydroxide at 150–160°[11a]. On the other hand, *o'*,*p*-dinitrohinokitiol (II : X_1 = H; $X_2 = X_3 = NO_2$) does not undergo rearrangement with alkali, but does so upon being heated with 50 per cent aqueous ethanol at 100° for 10 min., or with absolut methanol or ethanol at 50–60° for a few minut giving *o'*,*p*-dinitro-*m*-cumic acid (III : X_1 = H, $X_2 = X_3 = NO_2$) or its respective esters. By the utilization of such specific reactions, we have been able to determine substituent positions in some hinokitiol derivatives[11a].

Reduction of various azo[10a], nitroso[10f,14e] and nitro compounds[10b,14c] of tropolones by catalytic or other means gives aminotropolones in good yield. These aminotropolones, similar to benzenoid amines, when submitted to the Sandmeyer reactions[10a,13,16b], yield various halogeno and other derivatives. These facts not only point to the high aromaticity of tropoloids but also provide bases for the structural determination of various tropolone derivatives[11b,14]. Under certain reaction conditions, *p*-aminotropolones yielded what may be termed *p*-tropoquinones[16c], while *o*- and *o'*-aminohinokitiols yielded hydroxy derivatives of *o*- and *p*-cumic acids (that is, salicylic acid homologues) by the diazo reaction[11b,17].

Some workers in this field have recently taken up the question of the biogenetic relations of tropolones to the naturally occurring aromatic carboxylic acids[15,18], sugars[15], anthocyanins[19] and alkaloids[19]. These suggestions offer an attractive topic for research, although they must await further experimental evidence. In this connexion, also, study of the aromatization reactions of tropoloid compounds would be of great interest.

Pharmacological, antibiotic[18] and biological effects (for example, on Yoshida sarcoma[19]) of various

compounds of the tropoloid series have already been studied by our co-workers in these fields, and several reports have been published. [March 18.

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AUSTRALIAN UNIVERSITIES: THEIR FINANCIAL POSITION

By Sir DOUGLAS COPLAND, K.B.E., C.M.G.

Vice-Chancellor of the Australian National University, Canberra

UNDER the influence of rising costs and a doubling of student numbers, the running costs of Australian universities increased from about £850,000* in 1939 to about £1,850,000 in 1946 and £3,500,000 in 1950. The universities were unable to raise their revenues accordingly. Income from fees rose threefold; but the universities were reluctant to increase the scale of fees. As a proportion of running costs, revenue from fees has fallen from 26 per cent in 1939 to 21 per cent in 1950. Endowment income likewise has failed to keep pace with the increase in running costs, and the position was only partly saved by an increase in State grants from £350,000 in 1939 to £1,400,000 in 1950, and by the entry into the field, on a substantial scale, of the Australian Commonwealth Government. Before the War the Commonwealth Government had provided the universities with about £35,000 by way of special research grants and other grants for particular purposes. By 1950 this figure had risen to about £500,000, of which £300,000 represented subsidies for the training of ex-Service men and women (under the Commonwealth Reconstruction Training Scheme) and £110,000 a general grant for research and research training in the physical, biological and social sciences. In the immediate post-war years the Commonwealth Government had also provided generous financial assistance for capital purposes.

Even so, the universities were faced with the prospect of a combined deficit of about £350,000 in 1950, and the £300,000 they received as Commonwealth Reconstruction Training Scheme subsidies in 1950 was expected to diminish rapidly and completely to disappear in the space of another two or three years. The State Governments, themselves faced with financial difficulties, would have been hard pressed to fill this gap, and little relief could be expected from a fall in student numbers—until 1953 student numbers are expected to fall slightly, but their minimum level will be about twenty-eight thousand compared with fourteen thousand in 1939. The year 1951 also marks the beginning of a large-scale attempt by the Commonwealth Government to ensure a high level of university enrolments by means of its ambitious scholarship scheme, under which three thousand scholarships will be offered each year to students in universities and university-type institutions. As a result of this scheme, about ten thousand university students will receive financial assistance by way of fees paid, and in some cases living allowances, and no student should henceforth be debarred from completing a university course by reason of lack of finance. As a result of this scheme, and under the influence of the higher birth-rate in the late 'thirties and early 'forties, and the present large-scale immigration, student members are expected to expand rapidly after 1953. The significance of the scholarship scheme for university finances is that, taken by itself, it will involve the universities in further financial commitments without a commensurate increase in revenue—fees by themselves contribute only a part of the cost of tuition.

Even the significant increase in university expenditure that occurred between 1939 and 1950, moreover, did not enable the universities to operate on a scale in any way commensurate with their responsibilities to the nation. Compared with universities in the United States, of course, their revenues were pitifully low; but a rough comparison with Great Britain reveals quite clearly how the activities of Australian universities have been restricted through lack of finance. Excluding capital expenditure, the expenditure of British universities in 1948–49 amounted to approximately £240 per full-time equivalent student. In 1949 Australian universities were able to spend only some £120 on each of their students. Grants by the British Government averaged £150 in 1949–50 compared with an Australian figure of £75 (from both Commonwealth and State grants).

In endeavouring to keep within the financial 'strait-jacket' imposed by these conditions, the universities by the end of 1950 had reached a position which was described by the Australian Vice-Chancellors' Committee as follows: "Throughout the

* All values are expressed in Australian pounds, and where comparisons are made between expenditure in Great Britain and Australia, the British figures have been converted to Australian currency at the current rate of exchange.

Universities the pattern is almost invariably the same—unbalanced development as between faculties; salaries that are too low to attract overseas lecturers or to hold Australian staffs; inadequate teaching facilities; overworked staff who, in trying to maintain standards, have been preoccupied with teaching and administrative duties to the detriment of research; inadequate research facilities; repairs to buildings and plant that have to be deferred; and a deficit that somehow has to be met".

The vice-chancellors pointed out that up to that time the universities had been able to maintain their teaching standards, in spite of the tremendous problems caused by the doubling of student numbers after the War. But this had only been possible because of constant overwork and improvisation on the part of teaching staffs, and it was suggested that if no relief were afforded soon an appreciable lowering of standards would be inevitable. To provide the necessary relief the financial resources of the universities would have to be increased substantially.

This was the background against which the Commonwealth Government, early in 1950, had appointed a committee to inquire into the needs of Australian universities. The terms of reference of this committee were: to examine and report upon the finances of universities, having regard to their facilities for teaching and research, including staff, buildings and equipment; to examine and report upon the requirements of universities in relation to the work at present undertaken and to the need for their future development; and to make recommendations as to whether any, and if so what, action should be taken by the Commonwealth to assist the universities. The committee of inquiry is still considering the long-range developmental needs of the universities, but has submitted an interim report with recommendations designed to get the universities over their immediate financial difficulties.

On the basis of this report the Commonwealth Government has made an offer to the State Governments to provide financial assistance for their universities. Section 96 of the Commonwealth Constitution permits the Commonwealth Parliament to grant financial assistance to the States on such terms and conditions as it thinks fit. The State Governments have been traditionally regarded as responsible for the universities, and this principle has been preserved in the Commonwealth offer, the details of which are as follows.

(1) The present Commonwealth Reconstruction Training Scheme subsidies and the Commonwealth grant for research and research training in the physical, biological and social sciences (which together would have amounted to about £450,000 in 1950) will be replaced by a grant of £803,000 a year, including £25,000 for residential colleges. This grant will be allocated among the State universities in accordance with relative numbers of students (with special weighting for smaller universities) and will be made for each of three years from January 1, 1951. Before any university can qualify for this 'basic' grant, however, its State Government grants, plus fees, must reach a level at least three times the amount of the proposed Commonwealth grant. No restrictions have been placed upon the use of the Commonwealth grants, except a proviso that they shall not be applied towards capital extensions.

(2) To encourage State Governments to raise their grants, the Commonwealth will make a 'second-level' grant of £1 for every £3 by which State grants and fees exceed the amount necessary to enable the university to qualify for the basic grant (up to a limit of £300,000 a year spread over all the universities).

(3) If agreement with the States can be reached quickly enough, the Commonwealth offer will be back-dated to July 1, 1950, so as to enable the universities to receive £351,500 for the last six months of 1950 in place of the £225,000 (approximately) that they would have received under subsidies and the research grant of the Commonwealth Reconstruction Training Scheme.

If this offer is accepted by the State Governments, the immediate financial difficulties of the universities will be eased quite considerably. Altogether the universities might receive about an additional £1,000,000 in revenue in 1951 compared with 1950. This would be made up of about £425,000 additional Commonwealth assistance, about £225,000 increased fees and about £350,000 additional State grants needed to enable the universities to qualify for the larger Commonwealth grant.

About one-third of this new money will, in fact, be absorbed in covering 1950 deficits, and about half will be spent in paying long-overdue salary increases and increases that have already occurred in wages and other costs. There will thus be little left to provide for the new activities necessary if the universities are to develop at a satisfactory rate.

At a later meeting of the Australian Vice-Chancellors' Committee, in March this year, it was pointed out that the additional financial assistance would prevent further immediate deterioration in the position of the universities, but would not enable them to embark on forward-looking development. While the universities themselves are particularly anxious that the State Governments should maintain primary responsibility for their universities, the only hope of substantial university development from their present retarded position lies with the Commonwealth Government. For this reason, the long-term inquiry being made by the Commonwealth committee, to which reference has already been made in this article, has vital significance for the universities of Australia.

INSTITUTE OF JUTE TECHNOLOGY, CALCUTTA

THE traditional textile industries have always retained an element of craftsmanship in many of their technological processes, and experience, acquired in the hard way by trial and error in the mills, must still remain an important factor in the qualifications of an efficient operative. Nowadays, however, under the stimulus of competition, actual or potential, from the more modern processes of synthetic and regenerated fibres, the older industries which exploit the natural fibres have found it necessary to make more and more use of the results of the extensive research on fibres and fibre processing which has been carried out during the past thirty years; and the demand for an education with a scientific background, which will enable the higher grades of workmen to cope with the new situation thus brought about, has shown a steady rise. In Great Britain and the industrial West generally, there has been available a well-developed system of technical colleges and university departments adapted to deal with this demand at all levels.

Although the technical colleges have their place in the structural scheme of Indian education and have, in fact, included courses in textile technology in their curricula, the emphasis in India has in the past been placed almost entirely on cotton, to the exclusion of jute. The reason for this discrimination appears to have arisen from the traditional attitude of the jute mills, for the most part financed and managed by the British, towards the recruitment of men to fill the more responsible supervisory posts; until fairly recently the tendency was to import British-trained men, and there was consequently less demand by Indians for training in jute than in cotton technology. This attitude has had to be revised, however, because of the altered political and economic circumstances, and the industry is faced with the problem of finding suitably trained men for entry into the mills as supervisors.

The foundation of the Institute of Jute Technology in Calcutta is an attempt to solve this problem by providing a course of instruction, spread over three years, for 100–150 student-apprentices. To qualify for entry, candidates must have passed the equivalent of the intermediate science examination, to have reached, that is, the minimum standard for entry on a university degree course. The subjects studied at the Institute include the basic sciences—mathematics (including elementary statistics), physics, and chemistry—the production and characteristics of the vegetable fibres generally, the spinning and weaving of jute, analysis and testing, engineering and machine drawing, and business organization and administration. Besides this, about half the duration of the course will be spent in mills acquiring practical experience of the industry. Entrance is restricted to nominees of the mills, which pay the tuition fees and make a subsistence allowance to their nominees.

At present the full-time staff consists of the principal, three senior lecturers (engineering, physics and testing, and spinning and weaving) and a lecturer in textile chemistry; part-time lecturers deal with jute production and business organization, etc. The principal, C. R. Nodder, was formerly chief chemist to the Linen Industry Research Association in Belfast, and later director of the Technological Research Laboratories of the Indian Central Jute Committee.

The Institute was formally opened early in March by Dr. B. C. Roy, Chief Minister, West Bengal. The buildings, which were started in 1948, consist of two blocks: one, intended to house technological equipment, is not yet completed; the other, containing administrative offices, an assembly hall, common room, refectory, lecture rooms, laboratories and library, is already in use by the first batch of students. The buildings stand on about 1¼ acres of land. The estimated capital outlay, Rs. 2,000,000, and the provision of an annual running expenditure of Rs. 200,000, have been made by the Indian Jute Mills Association. The Institute is to be affiliated to the University of Calcutta and is to be administered jointly by the University and the Indian Jute Mills Association; the University has not, however, been called upon to shoulder any financial burden, although, in fact, the assets of the Institute are to be vested in it by a deed of trust.

From the point of view of the Institute, affiliation to the University, if it implies opportunities for students to share in non-academic activities (it is not clear at present whether this is, in fact, the intention), is an obvious advantage, as it would afford a possible counterpoise to the bias imposed by the restriction of the declared activities of the Institute to teaching. If it is the intention that students may ultimately graduate from supervisors to managers, some contact with active research is probably desirable. One obvious development along these lines suggests itself: the Indian Jute Mills Association already has a Research Institute in Calcutta, with a scientific staff in contact with both fundamental and processing research, and some sort of collaboration between the two Institutes, perhaps by means of colloquia in which selected current research topics could be discussed, could do much to help train the students as possible liaison men between the new Institute and their mills.

FIFTY YEARS OF SYSTEMATIC SEROLOGY

NUTTALL MEMORIAL CELEBRATION

THIS year may be said to mark the end of the first half-century of systematic serology, for it was in 1901 that the late Prof. G. H. F. Nuttall, emeritus professor of biology in the University of Cambridge, published the first reports describing the results of the testing of precipitin antisera with a variety of antigens of animal origin, and thereby started the science of comparative or systematic serology. In recognition of this anniversary, a Nuttall memorial celebration was held on March 19 at the Serological Museum of Rutgers University; during the afternoon there was an exhibition of the work of the Museum and of its Nuttall historical materials, and a tea for serologists and friends of the Museum. The materials exhibited included some of Nuttall's original fluid sera, four of his charts, and two sets of protocols relating to the researches in blood relationship, all of which had previously been in the care of Prof. D. Keilin, director of the Molteno Institute in the University of Cambridge, and were given to Dr. Alan Boyden, director of the Serological Museum, during the latter's visits to Cambridge last August.

The celebration was concluded with a symposium in the evening, sponsored by the Rutgers Chapter of Sigma Xi, entitled "A Half-Century of Systematic Serology; the Work of Nuttall and his Associates at Cambridge and of his Successors in America". Those participating were: Dr. T. C. Nelson, who gave an account of Nuttall based on his visits to Nuttall's laboratory and home in 1931; Dr. P. A. Moody, who reported on researches in systematic serology carried on in the University of Vermont under his direction; and Dr. Alan Boyden, who briefly summarized the more important old and new work in the field and gave an appraisal of the significance of Nuttall's contribution to it.

Dr. Boyden pointed out that Nuttall himself was aware of some of the limitations of his techniques. In 1902, after completing a series of quantitative tests in which he measured the volumes of settled precipitates, Nuttall said: "I do not wish these numbers to be taken as final, nevertheless they show the essential correctness of the previous crude results. To obtain a constant it will be necessary to make repeated tests with the bloods of each species and with different antiserums of one kind, making the tests with different proportions of antiserum. I am inclined to believe that with care we shall perhaps be able to measure species by this method, for

it appears from the above results that there are measurable differences in the reactions obtained with related bloods, in other words, determinable degrees of blood relationship which we may be able to formulate." These words, continued Dr. Boyden, were prophetic in that they pointed the way to future progress, and especially to the developments of the past decade.

Dr. Boyden then went on to describe briefly Nuttall's contributions to systematic serology. Besides being the first to have the insight to appreciate the potential significance of systematic serology and the enthusiasm to undertake an extensive study of its problems, Nuttall inspired a small band of workers, Dinkelspiel, Graham-Smith, Strangeways and Sanger, to join him in his studies of blood relationships, and they worked effectively together in building the foundation for the future. He and his associates demonstrated a general parallelism between the systematic positions of animals, where they seemed to be relatively certain, and the precipitin tests of their sera. In fact, among the quantitative tests, only about ten per cent are obvious errors in view of modern knowledge in regard to the relationships of the species tested. Finally, Nuttall and his co-workers provided evidence bearing upon the systematic positions of species or groups of doubtful relationship. Thus it was found that: an anti-limulus serum reacted more strongly with arachnid sera than with decapod sera; the sera of whales were more similar to the sera of even-toed ungulates than to those of any other orders of mammals tested (this has recently been confirmed); and the serum and egg proteins of birds show some evidence of similarity to those of chelonians and crocodiles.

A fuller account of the celebration, including the reports of the principal speakers, together with other matters of significance relating to the half-century of developments in systematic serology, has been published in the May issue of the *Bulletin of the Serological Museum*. Copies will be available upon request from the Director, Serological Museum, Rutgers University, New Brunswick, N.J.

PHYSICAL SOCIETY

ANNUAL GENERAL MEETING

AT the annual general meeting of the Physical Society, held at the Royal Institution on May 2, the reports of the Council and honorary treasurer and the accounts and balance sheet for 1950 were presented and adopted, and the officers for 1951–52 were elected as follows: *President*, Prof. L. F. Bates; *Vice-Presidents who have filled the office of president*, Dr. C. H. Lees, Sir Frank Smith, Sir Owen Richardson, Dr. W. H. Eccles, Prof. A. O. Rankine, T. Smith, Prof. Allan Ferguson, Sir Charles Darwin, Prof. E. N. da C. Andrade, Sir David Brunt, Prof. G. I. Finch, Prof. S. Chapman; *Vice-Presidents*, C. H. Collie, Prof. R. E. Peierls, Dr. D. Roaf, Dr. A. C. G. Menzies; *Honorary Secretaries*, C. G. Wynne, Dr. H. H. Hopkins; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Treasurer*, A. J. Philpot; *Honorary Librarian*, Dr. R. W. B. Pearse. The chairmen for 1950–51 of the four Groups of the Society are as follows: *Colour Group*, Dr. W. S. Stiles; *Optical Group*, Dr. A. C. G. Menzies; *Low Temperature Group*, Prof. F. E. Simon; *Acoustics Group*, H. L. Kirke.

During 1950 the membership of the Society rose to 1,936, with a net increase of forty. However, the figures given in the report show that since 1947 there has been a steady decline in the number of newly elected Fellows, together with a considerable number of resignations. The accounts show a favourable balance of income over expenditure of just over £2,000. The treasurer, nevertheless, points out that there are two sources of uneasiness in respect of the health of the Society's finances. The first is the dependence of the whole financial structure of the Society on the success of the annual exhibition of scientific instruments and apparatus. The balance of £2,000 mentioned previously was mainly due to the very large balance of receipts over expenditure, approximately £3,800, for the 1950 exhibition. The second source of uneasiness is the very heavy cost to the Society of the provision to its members of *Science Abstracts*.

In accordance with a recommendation of the papers committee, the science meetings of the Society have recently taken the form of general lectures or symposia in place of the presentation of papers on unconnected subjects. The marked increase in attendance at these meetings would appear to justify the new policy. Nine science meetings were held in London. A one-day meeting was held at the Billingham Division of the Imperial Chemical Industries, Ltd., and two-day meetings were arranged at the University of Liverpool in the summer and at the Cavendish Laboratory, Cambridge, in the winter. The thirty-fourth Guthrie Lecture was delivered by Prof. G. I. Finch, who spoke on the sliding surface, and the fifth Rutherford Lecture by Dr. A. S. Russell. P. Jacquinot, of the University of Paris, was the recipient of the fifth Holweck Medal of the Société Française de Physique and the Holweck Prize; the subject of his discourse was "Quelques recherches sur les raies faibles dans les spectres optiques", the text of which appears in the Society's *Proceedings*, B, **63**, 969 (December 1950). The twenty-seventh Duddell Medal was presented to Dr. D. W. Fry, who described his work on linear accelerators, and the sixth Charles Vernon Boys Prize to Dr. G. P. S. Occhialini, who spoke on physical problems in cosmic ray research.

The Society continues to be represented on various joint committees and bodies, details of which are listed in the annual report, together with details of the activities of the four Groups. It is of particular interest to note that twenty members of the Low Temperature Group visited France in April as the guests of L'Air Liquide to inspect low-temperature research and industry in that country, and that at the International Acoustical Meeting held in Marseilles in May it was agreed to establish *Acustica*, a European journal of acoustics, with Dr. E. G. Richardson (King's College, Newcastle) as the British editor.

The report omits mention of the various publications of the Society, though these are an essential and important item of the activities. Mention is made, however, of the fact that owing to the continued rise in the cost of publishing and the steady increase in the number of papers submitted for publication in the Society's *Proceedings*, the Council has considered possible changes in the organization of publication and the basis of membership. No specific recommendations have as yet been made; but it is stated that these will shortly be submitted for the consideration of members.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Latent Virus in Sugar-beets and Mangolds

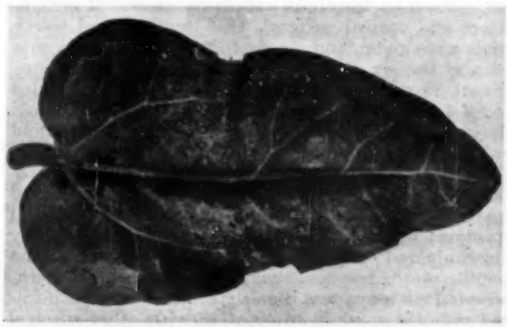
In a previous communication[1], a short description was given of a new virus isolated from a steckling mangold. Further investigation has revealed the interesting fact that this virus seems to be present in a latent condition in a high percentage of the ordinary seed beets and mangolds in the British Isles. Samples of apparently healthy sugar-beet and mangold stecklings collected at random from different farms in Essex, Cambridge, Lincoln and Scotland were all found to contain the virus. The concentration of virus differed considerably in the various lots, and the virus was not detected in every plant of each sample.

The presence of the virus can be rapidly demonstrated by inoculation of the sap to the first leaves of cowpea seedlings (see photograph), which results in the production of characteristic lesions. This method of testing also reveals clearly the differences in the concentration of virus in the samples. In some mangold stecklings the virus was in such low concentration that only one or two lesions would develop on the leaves of the cowpea. On the other hand, the virus concentration, especially in sugar-beet, would sometimes be sufficient to destroy the leaves of the test plant.

The virus appears to be very unstable. Although it may occur in high concentration, all attempts to isolate it by chemical means have failed, and it seems to be inactivated by high-speed centrifugation. The thermal inactivation point is very low, about 40° C., and the longevity *in vitro* is also short. Probably for these reasons it has not been possible to prepare an antiserum to it.

Since the virus is so widely distributed, it would appear, unless it is seed-transmitted, that there must be a common insect vector. So far, however, insect transmission tests have all failed.

The presence of latent or 'silent' viruses in plants and other organisms is not, of course, new. There are other examples in plants, and there seems little doubt that viruses are latent in a high percentage of apparently healthy caterpillars[2]. It is, however, unusual to find a symptomless virus so widespread as this one appears to be. At the moment, it seems to be innocuous to the sugar-beet crop; but its presence must nevertheless be regarded as a potential source of danger.



Leaf of cowpea inoculated from an apparently healthy sugar-beet, showing the lesions produced by the latent virus

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'Excessive Dose' Phenomenon in Virus Infections

It has often been observed that the administration to a susceptible host of an excessive infecting dose of virus may be followed by a reaction of considerably less intensity than that induced by a normal or small infecting dose[1]. This has been variously attributed to the presence of antibodies in the larger inoculum, or to the fact that attenuated or non-virulent particles[2,3] interfere with the development of the normal particles.

During an investigation of the interaction of *Salmonella typhi-murium* and certain of its symbiotic bacteriophages, particularly those of group *A* [4], an analogous phenomenon has been observed which has some bearing on this problem.

When cultures of an indicator organism growing in a liquid medium are exposed to different concentrations of type *A*1 phage particles, turbidity curves follow an unexpected course. Whereas in the case of a true lytic phage, such as one of the anti-*O* phages, a high initial concentration of particles (that is, excessive infecting dose) merely accelerates the onset of lysis, a similar concentration of type *A*1 phage causes bacterial growth to lag a little behind that of a normal phage-free culture of the bacteria but produces no obvious lysis. With both types of phage, when there is a low concentration of particles, a period of bacterial growth is followed by a sudden mass lysis. Furthermore, when the initial phage *A*1/bacteria ratio is high, there is but little increase in concentration of particles, while a high titre is reached in the culture with a low infecting dose.

If the growth-curve can be taken as an index of the 'well-being' of the organism, these results have all the characters of the 'excessive dose' effect as produced by certain animal viruses.

The immediate cause of this phenomenon has been definitely established. When bacteria are exposed to an excess of type *A*1 phage particles, a high percentage become symbiotically infected and so continue to multiply without significant lysis. On the other hand, when the ratio of phage particles to bacteria is low, symbiotic infection is infrequent; phage multiplies by the lytic cycle, the uninfected bacteria dividing normally until phage concentration overtakes bacterial concentration, when mass lysis occurs.

The underlying cause—the principle which determines whether phage infection shall result in symbiosis or lysis—is less certain. It may be that the invasion of a bacterium by more than one particle leads to the development of the symbiotic state; but it is difficult to understand how this would operate, or why it should apply to some phages (the symbiotic types) and not to others (the lytic types).

An alternative explanation is that the phenomenon is attributable to the existence of two types of particle, each occurring as a mutant of the other, giving a di-phasic type of variation. The occasional appearance of a lytic mutant in a symbiotically infected culture of bacteria would account for its 'lysogenicity', that is, the presence of free phage particles in the culture. Some of these are demonstrably lytic in nature, and when introduced into a growing culture of an indicator organism multiply to produce a high concentration of lytic particles. There is, however, evidence to suggest that during this lytic development a small number of variants with symbiotic tendencies are also produced. If it be postulated that the latter have a greater avidity than the lytic particles, so that in the presence of susceptible organisms the symbiotic particles dominate and establish themselves to the exclusion of the lytic particles, a feasible explanation of the anomalous growth-curve presents itself. An excessive dose of phage contains a sufficient number of symbiotic particles to infect a significant number of bacteria. Conversely, at a low concentration of phage, few, if any, particles with symbiotic tendencies are present and multiplication follows the lytic pattern.

It cannot be assumed that the cause of the excessive dose phenomenon is the same in the case of animal viruses as it is for this bacterial virus. Nevertheless, this is a possibility which is worthy of investigation. The fundamental conception—an innocuous symbiont which normally protects its host-cell but sheds from time to time virulent (lytic) variants which are, in their turn, endowed with the capacity of producing variants with symbiotic tendencies—is one which might afford an explanation of several obscure problems in the etiology of virus diseases.

Full details of this work are being published elsewhere.

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Sensitivity of the Cat's Eye to Infra-red Radiations

The sensitivity of the eyes of nocturnal animals to infra-red radiations has long been a matter of much speculation. Sensitivity into the far infra-red has been claimed by Vanderplank[1] for the owl—an animal with a rod retina; Matthews and Matthews[2], however, working on the same animal, did not find any retinal action potentials in response to infra-red stimulation, and Hecht and Pirenne[3], who were using the pupillo-motor response of the owl's eye as an index of wave-length sensitivity, found no observable contraction in response to stimulation with infra-red radiations of an energy content of 5×10^6 times that of green light, which produced a marked iris contraction.

Using the training method, Wojtusiak[4] and Wojtusiak and Mlynarski[5] have claimed to have observed sensitivity to the infra-red in the water tortoise, whose retina contains cones almost exclusively.

In the course of experiments on the luminosity function of the cat[6], measurements were made on the absolute lower threshold for vision in this animal under conditions of complete dark-adaptation. These results were obtained by a method of discrimination in a *Y*-shaped choice box. The values obtained for the threshold were lower by a factor of about 6 than the similar values for man obtained under identical conditions. This relatively low absolute threshold value for the cat might be explained by the relative speed (*f* value) of the animal's dioptric mechanism as well as by the reflexion from its tapetum, so that a retinal sensitivity probably equal to, but not greater than, man's can be assumed for this animal.

In order to examine the infra-red sensitivity of the visual mechanism of the animal, which possesses a mixed retina containing a fair number of cones, six cats previously trained in the brightness discrimination habit were re-tested under conditions described above to respond positively to the less bright of two white-light stimuli, the relative intensities of which had a ratio of 1 : 50, the intensity of the brighter being 100 ft.c. When this discrimination had been learned by all cats to a criterion of 100 per cent correct response in twenty consecutive trials, darkness was substituted for the low-intensity stimulus. In this stimulus situation all animals responded positively to darkness in 92 out of 100 trials.

In the test experiment, an infra-red filter combination (Ilford 207 and 813, transmitting no wave-length shorter than 7,400 A.) was then interposed in the light beam, and the animals were required to discriminate between this on one stimulus panel and darkness on the other (all stimuli being presented in random order). To this stimulus situation the response fell to random level, and observation showed complete indecision of choice on the part of the animals. In order to avoid the interference of these test responses with the experiment, the 40 responses to the infra-red versus darkness situation were collected out of a total of 80 trials, one-half of which were responses to the ordinary high-ratio intensity discrimination to which all animals consistently responded correctly, and for which they were rewarded.

Having thus established that the animals, under the conditions of the experiment, could not discriminate between darkness and infra-red, the test situation was changed to determine the response of the animals to a stimulus situation requiring discrimination between infra-red radiations and white light, the intensity of which was decreased in small steps down to threshold values by means of neutral filters and optical wedges. One hundred and thirty trials were given, and a computation of the aggregate data of the six cats to this situation showed a consistent 89 per cent positive response to the stimulus panel bearing the infra-red radiations, even though the intensity of the white light was as low as threshold value.

The light intensity of the source behind the infra-red filter with which the above results were obtained was 10^6 times the light intensity behind an Ilford spectrum green filter, which all animals consistently discriminated from darkness. Furthermore, no pupillo-motor response was observed when the dark-adapted cat's eye was directly stimulated with infra-red radiations, while stimulation with other spectral colours showed an easily observable contraction of the iris.

The evidence adduced above seems consistent with the view that infra-red radiations in the amounts used in the present experiment have no visual stimulus value for the animal's dark-adapted eye, and are subjectively equal to darkness for the cat.

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Analogous Effects of Radiation and Trypan Blue on Rats Resistant to Transplanted Hepatoma

IN the course of an experiment on the radiobiology of the liver carcinoma of the rat induced by butter-yellow, an attempt was made to transmit the autogenous tumour by transplantation into the subcutaneous tissues of young animals of the same strain. The strain of albino rat used as hosts was not, however, sufficiently homogeneous, and a high percentage of spontaneous regressions occurred in these animals in spite of repeated passage. A group of resistant rat hosts was thus obtained in which the inoculated tumours had grown for about a fortnight, and then rapidly regressed to small, barely palpable nodules. In view of the known ability of total body radiation[1] and trypan blue[2] to depress the host's resistance to tumour, these animals were divided into four groups, one of which was treated with total body irradiation (central body dose: 525 r., 240 kV., *HVL* 1·5 mm. copper); in another, each animal was injected subcutaneously with 2 ml. of a 0·5 per cent aqueous solution of trypan blue; a third group was placed on the standard hepatoma-inducing butter-yellow diet, and a fourth group used as controls.

In both the irradiated group and that receiving trypan blue injection, the tumour remnants recommenced growing vigorously and progressively in every case and, in the ensuing four months, they ulcerated through the skin, necessitating the destruction of the animals. At autopsy, the homoplasts were found to be actively infiltrating skin and subcutaneous tissues but without distant metastases. An additional feature was the tendency in both groups to chronic infection and infestation, as evidenced by bronchiectatic lesions of the lung, cysticercosis of the liver, and splenomegaly with microscopic features reminiscent of Rosenthal and Zohman's description[3] of *Bartonella muris* infection induced by reticulo-endothelial blockade. In contrast to this, both the group on the butter-yellow diet and the untreated control group showed none of the infective features, and exhibited complete regression of the nodules with no recurrences during a six-month observation period.

It is concluded, first, that these stock albino rats are not normally susceptible to transmitted hepatoma chemically induced in the same strain, and secondly, that this resistance may be completely overcome by a single injection of trypan blue or a single sub-lethal exposure to total body irradiation. This fact, which re-emphasizes previously established observations, may be of value to other experimenters desirous of transmitting tumours normally non-transmissible.

In view of the agreement between this observation and Ludford's original findings, it is not improbable that trypan blue, by deranging some resistance mechanism, may eventually activate and disseminate latent spontaneous tumours (by no means infrequent in the rat species[4]), and render the rat host susceptible to chronic infections, including bartonellosis and cysticercosis, the latter of which is known to induce sarcoma[5]. Recent reports on the alleged carcinogenic action of trypan blue[6] should therefore be treated with reserve.

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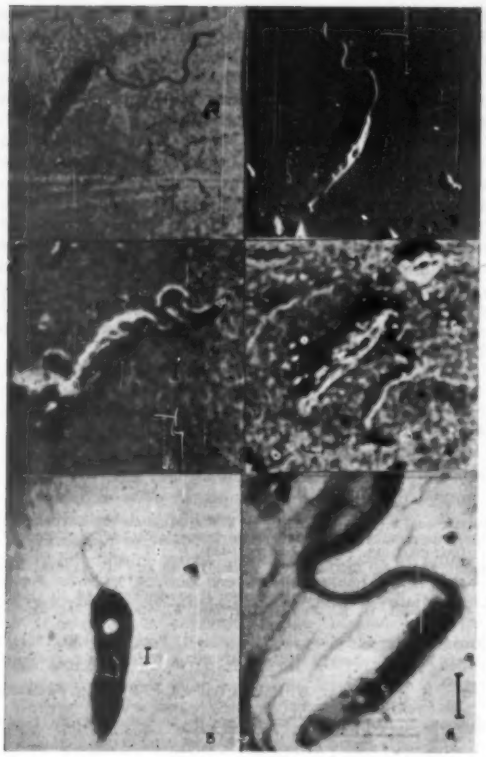
Electron and Photomicrographic Studies of the Flagellate Form of *Leishmania donovani*

THE technique of shadowing specimens with metal vapour in high vacuum is now a frequent practice in electron microscopy[1]. The same technique may also be used with advantage in photomicrography, in order to bring out details of surface structure which are otherwise invisible. The present work is a study of the flagellate form of *Leishmania donovani*, the parasite of kala-azar, both with electron and shadowed photomicrographs.

Fig. 1 is a photomicrograph of this parasite fixed and stained in the usual way with Leishman stain. The photomicrographs 2, 3 and 4 were obtained after oblique deposition of about 100 angstroms of silver deposited at an angle of about $\tan^{-1} \frac{1}{4}$. Unstained smears exposed to osmic acid vapour and fixed in methyl alcohol were shadowed with silver. These shadow micrographs show details of surface structure of the flagellate form of *Leishmania donovani*.

The body of the flagellate shows several well-defined elevations and depressions or clefts. There is a large oval-shaped bulge corresponding to the site of the nucleus; this measures about 3·2 microns in length and 1·7 microns in maximum width. There is a small elevation of approximate diameter 0·77 micron about the centre of the nucleus corresponding to the nucleolus. The parabasal body is seen as a rod-shaped elevation just anterior to the nucleus,



Photomicrographs (1–4) and electron micrographs (5–6) of *Leishmania donovani* (flagellate form). Scale on each photograph equals 1 μ

(1) Stained with Leishman stain. × 1,200. (2) Unstained but shadowed with silver. × 1,350. (3 and 4) Shadowed flagellate. × 1,870. (5) × 2,250. (6) After hydrolysis according to Robinow's method. × 6,750

and from a slightly bulbous area (rhizoplast) in relation to it rises the flagellum, which is seen to run as a ridge to the anterior end of the body of the parasite and then as the free flagellum. The flagellum is about 0·35 micron thick. There is another ridge extending from the anterior end of the nucleus to the flagellum near the end of the body of the flagellate. There is a depressed area between the parabasal and the edge of the parasite corresponding to the flagellar vacuole. A cleft or depression is also visible on the body of the parasite extending anteriorly from a little behind the middle of the nucleus. Another depression is apparent posterior to the nucleus, dividing this portion of the body of the parasite in two nearly equal halves (Fig. 4).

An attempt was made to study the internal structure of the flagellate with the help of the electron microscope. Normally, the flagellate is too thick for the penetration of 50-kV. electrons, and it appears as an opaque body except for the region of the nuclear vacuole (Fig. 5). By subjecting the specimens to hydrolysis according to the technique described by Robinow[2], it has been possible to obtain more transparent micrographs showing opacities corresponding to the sites of chromatin material (Fig. 6). Further studies are in progress.

Our thanks are due to the Ministry of Education, Government of India, for grants supporting this research. We are also indebted to Prof. M. N. Saha for his interest in this work.

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Action of Growth Hormone on Isolated Rat Diaphragm

Insulin has been found by many workers to increase the rate of glucose utilization of rat diaphragm muscle *in vitro*. It has been observed[1] that if the diaphragm is given a preliminary incubation for 30 min. or less, in a crude extract of anterior pituitary glands, the rates of glucose utilization and of glycogen synthesis in a subsequent normal incubation are unaffected by insulin. A similar system has since been used by Stadie *et al.*[2,3], who measured glycogen synthesis only, and their results have confirmed this finding.

It seemed probable that the factor suppressing insulin action in these experiments was the growth hormone, which is known to have a 'diabetogenic' action[4]. It has now been found, however, that when diaphragm muscle is given a preliminary incubation in a solution of purified growth hormone, prepared by the method of Fishman, Russell and Wilhelmi[5], the subsequent stimulation of glucose utilization by insulin is unaffected. Further, the growth hormone itself stimulated glucose utilization, although it was only present in the solution during the first incubation. This 'insulin-like' action of growth hormone is illustrated by the results given in Tables 1 and 2.

One point of interest emerging from these results is that the minimum concentration of growth hor-

Table 1. Rate of Glucose Utilization by Isolated Rat Diaphragm (mgm./gm. wet weight/hr.)

Addition to preliminary incubation medium	No. of experiments	Final incubation	
		Without insulin	With insulin
None	19	2·32	3·16
Growth hormone			
50 μgm./ml.	5	2·52	3·26
100 μgm./ml.	12	3·40	3·27
200 μgm./ml.	2	3·87	3·39
Crude pituitary extract	8	2·23	2·27

Table 2. Glycogen Content of Rat Diaphragm After Incubation (mgm./gm.)

Addition to preliminary incubation medium	No. of experiments	Final incubation	
		Without insulin	With insulin
None	15	1·8	2·4
Growth hormone			
50 μgm./ml.	5	1·4	1·5
100 μgm./ml.	7	2·6	2·4
200 μgm./ml.	2	2·65	2·65
Crude pituitary extract		1·65	1·75

Hemidiaphragms incubated in sodium phosphate – sodium chloride buffer, glucose conc. 80 μgm./ml. and with additions noted for 20 min. at 37°. Transferred to fresh buffer containing 2 mgm./ml. glucose and incubated for further 90 min. at 37°. Insulin concentration when added, 8 μgm./ml. All flasks gassed with oxygen.

mone effective in raising glucose utilization is of the order of 50–100 μgm./ml., whereas insulin is active at concentrations of 4 μgm./ml. or even less. It is not clear whether this is due to the slow diffusion into the tissue of a large molecule, or to the active molecule being, in fact, an impurity. The specimens of growth hormone used were crystalline; but this does not, of course, imply homogeneity.

Details of the technique used will shortly be published elsewhere; but it must be pointed out that during the preliminary incubation only a trace of glucose is present, and it seemed desirable to examine the action of growth hormone on diaphragm when it was not deprived of glucose at any stage. Pieces of muscle were therefore incubated in the buffer described by Stadie[4] with the addition of growth hormone, or insulin, or both. The results are shown in Table 3.

Table 3. GLUCOSE UTILIZATION BY ISOLATED DIAPHRAGM (mgm./gm. wet weight/hr.)

Addition to medium	No. of experiments	Rate of utilization
None	8	2·73
Insulin, 8 μgm./ml.	4	4·50
Growth hormone, 100 μgm./ml.	8	1·74
Insulin + growth hormone	4	4·28

It is evident that in the absence of added insulin, growth hormone inhibits glucose utilization considerably.

That glucose utilization should be decreased by pituitary growth hormone agrees well with the 'diabetogenic' activity of the hormone when it is injected *in vivo*. Milman and Russell[7] did find that injected growth hormone lowered the blood sugar of all but diabetic rats; but they ascribed this to an increase in insulin secretion. It is clear, however, that a simple inhibition of hexokinase activity by growth hormone, which is reversed by insulin, will not easily explain the increased glucose utilization produced in other conditions, however unphysiological these may be. Further work is in progress to clarify the mechanism involved.

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A Factor Modifying Muscle Fibre Synæresis

IN an attempt to extend observations on the synæresis of actomyosin by adenosine triphosphate to a less disorganized and more physiologically complete system, the volume changes which accompany the disappearance of the latter in a muscle fibre suspension are being studied. Small (2-gm.) samples of fresh rabbit psoas muscle are broken up in isotonic potassium chloride solution to particles of single-fibre diameter and approximately 1 mm. in length. This system has the advantage that, while a high degree of intrafibrillar organization is retained, such substances as salts, adenosine triphosphate and enzyme inhibitors are easily introduced and their effects on fibre-volume readily observed. The suspensions are spun in a centrifuge modified to permit continuous reading of the volume occupied by the fibres. Results so far obtained are here briefly summarized.

When a homogenate of fresh muscle is centrifuged, the volume occupied by the fibres remains constant, or diminishes only slightly, for some minutes: a synæresis then occurs (the 'rapid phase'), the fibre volume decreasing by 20–40 per cent. Thereafter the volume remains practically constant. The rapid phase occurs in all fresh glycolysing muscle preparations, regardless of the glycogen-level or the degree of fatigue of the animal before death. It commences when the adenosine triphosphate content has reached about a sixth to an eighth of its level in whole resting muscle, the triphosphate being removed from the fibre phase both by enzymic decomposition and by centrifugal displacement into the supernatant fluid. As in intact muscle[1], the duration of the initial delay period is dependent on the glycogen reserve, being longest in the muscles of well-fed, well-rested animals. The extent of the synæresis during the rapid phase is dependent on the velocity of synæresis; a total decrease in volume of 20 per cent takes about 20 min., whereas a 40 per cent synæresis will occur if the rapid phase requires only 6–8 min. for completion. The extent of the volume change can be controlled by the degree of comminution, becoming greater with decreasing particle size.

Synæresis can be reversed by the addition of adenosine triphosphate, the volume rising to almost its original high value, and after a delay of up to 5 min., falling rapidly to about its previous minimum. The volume change may be reversed several times by further additions of adenosine triphosphate; inorganic phosphate and pyrophosphate, however, cause no such reversal. Such reversible volume changes have been obtained in rigor muscle, even after storage at 0° C. for 24 hr. The extent of reversal becomes less with decreasing *p*H in the range 7·2–5·8.

Sometimes, however, the addition of adenosine triphosphate to a suspension of rigor muscle produces an opposite effect, namely, an immediate further synæresis giving a volume only about 70 per cent of that before addition of adenosine triphosphate, or about one-half of the volume of fresh muscle before the 'rapid phase' occurred. This larger synæresis is not reversed by further addition of adenosine triphosphate.

Thus adenosine triphosphate may produce either of two effects in a muscle brei: the fibre volume may rise reversibly by almost 40 per cent, or it may fall suddenly and irreversibly by about 20–40 per cent. The influence of a factor determining the effect of added adenosine triphosphate is detected when the reactions of a washed brei are studied, that is, when the supernatant potassium chloride solution, which contains the sarcoplasmic proteins, is replaced before addition of adenosine triphosphate by fresh potassium chloride of the same molarity. In this system, at any *p*H in the physiological range, adenosine triphosphate produces only a large synæresis. Thus there appears to be a substance or substances in muscle, easily removable by dilute potassium chloride solution, the presence or absence of which determines the effect adenosine triphosphate will produce.

The two types of volume change detected in the centrifuge have also been observed under the microscope on short lengths (0·2–1 mm.) of single fibres removed from the homogenate. The irreversible synæresis is seen (in washed fibres) as a shortening to about 30–45 per cent of the original length, accompanied by thickening of about 30–60 per cent, resulting in a volume decrease of about 20–30 per cent. When fibres are bathed in the 'active' supernatant fluid at *p*H 6·8–7·1, the reversible increase in volume is seen as a considerable increase in length, usually of about 40 per cent, but in a few cases of 60–70 per cent, followed by a comparatively rapid shortening to about the original length before addition of adenosine triphosphate.

The substance (or substances) present in the supernatant fluid and responsible for this effect has not yet been identified; it appears to be water-soluble and non-dialysable. However, if dialysis against distilled water is continued at 0° C. for 24 hr., almost all activity is lost, and is not regained by the addition of the concentrated diffusate.

It has been found that when the labile factor is present in the extract (as shown by a reversible volume increase in the centrifuge test), there is a comparatively slow enzymic decomposition of adenosine triphosphate, while in its absence inorganic phosphate production from adenosine triphosphate is about ten times as rapid. So far, a separation of the two effects has not been achieved, high adenosine triphosphatase activity always being accompanied by irreversible synæresis, and low activity by reversible volume increase.

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Peripheral Inhibition in the Locust

The presence, in the decapod Crustacea, of peripheral inhibitory nerve fibres has been known for many years[1]. Few investigations have been made of the peripheral innervation of the limbs of insects[2–4], and no comparable inhibition has been demonstrated in this group. Friedrich, working with *Dixippus morosus* (Brunner), claimed that if, after severance from the ganglion, the nerve to the metathoracic leg was stimulated at very low intensity, the tibial muscles relaxed beyond their normal resting length. This he regarded as proof of the presence of an inhibitory nerve.

We have made an examination of the properties of nerve muscle preparations of the levators and depressors of the tibia and tarsus of the metathoracic limb of *Locusta migratoria migratorioides* R. and F. The main nerve trunk to the limb was exposed in the thorax of a decapitated locust and severed from its ganglion. The nerve was stimulated with a square-wave oscillator[5] using platinum electrodes. Contractions of the tibial muscles were recorded isometrically. The tarsal muscles, which are very weak, were recorded from the movements of the tarsus with a light isotonic lever. The anatomical arrangements within the tibio-tarsal joint are such that both tarsal muscles contract under almost isometric conditions, while the mechanical relations in the joint ensure that the tarsus itself acts as an auxotonic lever. The antagonist to the muscle being studied was severed at its insertion and the pretarsal joint cut off to free its apodeme.

Record from the levator tarsus of *Locusta*. Stimulation frequency, 21 c./s. Time marker, 1-sec. intervals

All the preparations showed properties similar to those found by Pringle[3] for the 'fast' fibre innervation in the cockroach. However, in a limited number of preparations of the levator tarsus of gregarious phase—but not solitary phase—locusts, evidence of peripheral inhibition was found. In these preparations an increase in the intensity of stimulation to values about three times threshold caused a marked reduction in the size of the mechanical response. The effect has been shown to occur over a stimulation frequency range of 15–125 c./s. A typical trace showing the effect is reproduced. The record shows the mechanical response to stimulation at an intensity 40 mV. above threshold, at three times threshold and again at the original intensity. The preparation was allowed to rest for two minutes after each stimulation. Subsequent dissection showed that the antagonistic depressor had been completely severed at its tarsal insertion, the depressor-pretarsus apodeme was free in the articulation and both nerve and levator muscle appeared to be in good condition. Experiments with the other three muscles show that high-frequency stimuli cause no depression of the contraction even at intensities twenty times threshold. This seems to exclude the possibility that the inhibitory effect is due to some depolarization phenomenon or to Wedensky inhibition. We are therefore of the opinion that the effect is a true peripheral inhibition.

No such effect has been demonstrated with the other three muscles studied. These are all much 'faster' than the levator tarsus. Wiersma and Ellis[6], using Crustacea, have shown that if both motor and inhibitory fibres are stimulated at the same frequency, the extent of the inhibition decreases as the 'speed' of the muscle increases; in these conditions contractions of crustacean fast muscle cannot be inhibited at all. In our experiments all fibres are stimulated at the same frequency. It is therefore possible that this has precluded the demonstration of inhibition in the faster muscles of the locust. A definite statement must wait upon the use of single axon preparations.

Finally, we would like to record that we have occasionally observed effects recalling the super-relaxation reported by Friedrich[3]. This we consider to be an artefact. The threshold of the nerves to the coxal muscles of the metathoracic limb is less than that of either the tibia or the tarsus. In a preparation in which the femur is not adequately secured, contraction of the coxal muscles causes

depression of the femur and stretching of the leg. This movement will be transmitted to the recording system and will allow the recording lever to move downward, thus giving an impression of super-relaxation of the tibial or tarsal muscles. Our records of inhibition cannot be due to this movement, as we have also been able to obtain them with perfused preparations of the isolated tibia–tarsus.

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Influence of Folic Acid and Vitamin B_{12} on Formation of Creatine *in vitro* and *in vivo*

Several recent reports have recorded an influence of folic acid on biological methylation[1,2], creatine excretion[3] and choline oxidase activity[4]. A metabolic relationship between vitamin B_{12}, choline and methionine has also been established[2,5]. These and other observed general inter-relationships between folic acid and vitamin B_{12} [6] suggested the present studies on the transmethylation of glycocyamine by liver enzymes (cf. ref. 7) and on *in vivo* formation of creatine.

Groups of 8–10 adult mice (Swiss strain), 25–30 gm. in weight, were maintained on a purified ration consisting of:

Alcohol-extracted casein	10 per cent	Salt mixture (U.S.P. No. 2)	4 per cent
Sesame oil	6 "	Sucrose	10 "
Shark liver oil	2 "	Starch	68 "

with the following vitamin additions (in mgm. per kgm. of diet):

Thiamine hydrochloride	6	α-Tocopherol	50
Pyridoxine hydrochloride	6	Nicotinic acid	30
Calcium pantothenate	20	Choline chloride	500
p-Amino-benzoic acid	100	Inositol	500
Riboflavin	10	Menadione	10
Biotin	1		

Folic acid (Lederle) and vitamin B_{12} (Pfizer, parenteral quality) were administered separately in daily oral doses, as indicated for the different groups in the tabular statement below. All animals received a daily subcutaneous injection of 0·01 mgm. of *l*-thyroxine (Glaxo) throughout the experimental period. The vitamin additions provided in the basal diet were considered adequate for this hyperthyroid condition[8], which was expected to hasten the onset of deficiencies in folic acid or vitamin B_{12} or both (cf. ref. 9). Animals from each of the four groups were sacrificed at the end of 12, 17 and 23 days; the livers were quickly removed, chilled, homogenized with 10 parts of ice-cold 0·2 *M* phosphate buffer of *p*H 7·4 and used for studying creatine synthesis *in vitro* from glycocyamine (Roche) and methionine by some modifications in earlier procedures[7].

Preliminary experiments with liver slices did not show any marked advantage over the use of homogenates. Contrary to the observation of Binkley and Watson[7], anaerobic conditions were found inoperative, whereas addition of adenosinetriphosphate to the reaction mixture could effectively be replaced by use of citrate and fumarate, preferably together. That the Jaffe-reactive substance thus determined was probably all creatine was ensured from a number of recovery experiments.

The procedure finally adopted was as follows: 2 c.c. of homogenate plus 1 c.c. each of methionine (equivalent to 6 mgm.) and glycocyamine (equivalent to 1 mgm.) solutions in phosphate buffer together with 1 c.c. each of 0·01 *M* sodium citrate and 0·0015 *M* sodium fumarate were incubated at 37° for 4 hr. with occasional shaking. Reaction was stopped by addition of 0·3 c.c. of 100 per cent trichloracetic acid, which also served to precipitate the proteins, which were removed by filtration. Creatine in the filtrate was determined as creatinine by a standardized Jaffe procedure using for colour measurement the Klett–Summerson photocolorimeter with filter 54 in position. Necessary controls with glycocyamine and/or methionine were also run, and all values reported represent in each case increments after the incubation period over the zero-time digest prepared in an exactly similar manner.

Parallel determinations on hæmoglobin contents and red cell counts were carried out on blood samples secured prior to killing the mice. The accompanying table summarizes some typical results after allowing for the appropriate controls, together with the values for total creatine in skeletal muscle and in the urine voided for the 24-hr. period preceding death.

Under the conditions of these experiments with thyroxine administration, definite deficiencies of folic acid and vitamin B_{12} were inferable from the blood picture at the end of twelve days. There was no marked difference in the extent of creatine formation *in vitro* during the three periods of sampling.

It can be seen that deficiency of either folic acid or vitamin B_{12} causes a diminution in creatine formation and excretion; together, their effects are additive. There is reason to believe that creatine formation is primarily influenced by folic acid and that vitamin B_{12} exerts its effect by promoting better utilization of folic acid at low levels (cf. ref. 6,2). It is possible that in the absence of folic acid there is a drain on the methyl economy due to methionine and choline, giving rise to formate[10]; that formate utilization is favoured by folic acid is now known[11]. The possible influence of formate on transmethylation reactions in folic acid deficiency is being ascertained more directly in experiments now in progress.

In an earlier series of experiments with groups of mice on a complete purified diet with and without vitamin B_{12} and with *l*-thyroxine fed orally (0·01 mgm. per day) for 27 days, and with 0·2 per cent iodinated casein added to the diets for a further eight days, results similar to the above were obtained.

Group	Supplements: Folic acid (gamma)	Supplements: Vitamin B_{12} (gamma)	Creatine per gm. of liver (gamma)	Per cent creatine in wet muscle	Creatine in 24-hr. urine per 100 gm. body-weight (mgm.)	Red blood cells per c.mm. (millions)	Hæmoglobin (per cent of positive control)
1	3·0	0·5	52·2	0·174	0·628	8·55	100
2	3·0	nil	30·4	0·164	0·596	7·75	90·0
3	0·3	0·5	20·8	0·159	—	5·75	92·3
4	0·3	nil	4·3	0·155	0·387	6·00	10·8

The favourable effect of vitamin B_{12} could not be observed in attempts at *in vitro* activation of the creatine-forming system by additions of vitamin B_{12} solutions.

An incidental observation that emerged in the course of the foregoing studies was a high mortality-rate in the vitamin B_{12}-deficient groups; the correction of thyrotoxic symptoms by vitamin B_{12} has since been recorded[12].

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Isolation of Sarcosine from an Acid Hydrolysate of Groundnut Protein

A two-dimensional paper chromatogram of an acid hydrolysate of groundnut protein has shown, in addition to the spots due to the amino-acids previously reported present in groundnut protein[1], a glycine spot (R_F = 0·32, 80 per cent aqueous phenol; R_F = 0·22, butanol–acetic acid) and an unidentified spot (R_F = 0·78, 80 per cent aqueous phenol; R_F = 0·24 butanol–acetic acid mixture). The R_F values of the unidentified spot did not correspond with any of the values reported for amino-acids[2] or amino-sugars[3].

Dalgleish, Johnson, Todd and Vining[4] have recently isolated sarcosine from the antibiotic actinomycin, and it was noted that the R_F values they recorded for sarcosine were similar to those found for the unidentified spot on the groundnut protein hydrolysate chromatogram. A synthetic sample of sarcosine was prepared[5], and its R_F values using different solvents were measured. In the accompanying table the R_F values of the unidentified spot are compared with the values found for sarcosine.

From the R_F values it seemed very likely that the unidentified spot was due to sarcosine. The unidentified spot was still present on the two-dimensional paper chromatogram of the deaminated hydrolysate, obtained by treatment with nitrous acid under conditions which re-form the secondary amine from its nitroso derivative[6], showing that the spot is derived from a secondary amino-compound.

	R_F value		
	80 per cent phenol	Butanol–acetic acid (ref. 3) mixture	80 per cent phenol/1 per cent ammonia
Unidentified spot	0·78	0·24	0·75
Sarcosine	0·78	0·24	0·76
Sarcosine values found by Dalgleish *et al.* (*loc. cit.*)	0·78	0·25	—

Final proof that the unidentified spot was due to sarcosine was obtained by isolating sarcosine from the groundnut protein hydrolysate. The groundnut protein hydrolysate was shaken up with charcoal to remove tyrosine and phenylalanine and then fractionated on a column of 'Zeocarb. 215' [7], when a fraction containing alanine, proline, valine and sarcosine was obtained. This fraction was further separated on a cellulose column[4], when a fraction containing sarcosine and alanine was obtained. Purification by fractional crystallization from alcohol and a methanol–acetone mixture gave sarcosine (m.p. 209–210° C. decomp.), 2–3 mgm. from 7·5 gm. protein. Cocker and Lapworth[5] give a melting point of 212° C. (decomp.) for sarcosine.

So far as is known, sarcosine has not been previously reported present in a protein hydrolysate, although it occurs in the free state in biological extracts.

The groundnut protein used in the above experiments was supplied by Imperial Chemical Industries, Ltd., Nobel Division, and was isolated from groundnuts by the procedure outlined by Haworth, MacGillivray and Peacock[7]. It is a mixture of arachin and conarachin. The sarcosine spot was observed in two different samples of groundnut protein isolated by the above method.

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Evidence of a Complex Compound of Cobalt with a Purine Base (Adenine)

It has been known for a long time that most amino-acids have the property of forming complexes with heavy metals, and it has now been shown[1] that the cobaltous ion, Co^{++}, combines reversibly with histidine, giving a tetra-co-ordinated compound, cobalto-dihistidine, which takes up oxygen reversibly to form a compound of octahedral configuration, oxy-*bis*-cobalto-dihistidine.

The analogy between the structure of histidine and that of the purine adenine (and the possibility in the purine molecule for resonance between differently charged structures) suggests that this also might form a complex with the cobalt ion. Complementary to the study of the uptake and distribution of cobalt in living organisms including malignant tissue[2], the possibility of its fixation *in vitro* by the constituents of nucleic acids has been investigated.

The properties of aqueous solutions containing cobaltous salts and adenine in various proportions (*c.* 0·01 *M* concentration) and at different *p*H's have been examined with the following results. At *p*H 7 the colour of the solution is light pink, changing to blue-mauve when the *p*H is progressively raised. At *p*H 7·3 a light brown precipitate appears which redissolves when further alkali is added (*p*H 8·5), the colour becoming in time a dark golden-brown in the presence of air.

The ratios of adenine to cobalt in various specimens of the precipitate obtained at different values of *p*H between 7·3 and 8·5 have been determined. The quantity of adenine present has been estimated by the technique developed by Woodhouse[3], and was also confirmed by ultra-violet spectrophotometric analysis. Cobalt has been determined colorimetrically by the α-nitroso-β-naphthol reaction, with parallel determination using radioactive cobalt-60 as a tracer element. A known weight of radioactive cobalt in the metal form was dissolved in hydrochloric acid, and the specific radioactivity (number of counts per gram of cobalt) was determined. Adenine was added to the solution, and the precipitates obtained as before, at *p*H values slightly higher than 7, were assayed for radioactive cobalt. The ratios of adenine/cobalt obtained colorimetrically in five samples of the precipitate were 0·90, 0·93, 1·06, 1·15 and 0·95. For one sample, values of 1·00 and 1·03 were obtained by the isotopic method for determination of cobalt.

Measurements of the magnetic susceptibility of the brown alkaline solution have shown it to be diamagnetic, the specific magnetic susceptibility being slightly greater than that of water. It would thus appear that in the precipitate cobalt and adenine form a complex in definite proportions, which in alkaline solution has no free electrons.

The method employed by Ley and Winkler[4] to prepare heavy-metal complexes of amino-acids was applied; by mixing adenine and freshly prepared cobaltous hydroxide and heating gently on a water-bath, a product was obtained which on analysis gave the same ratio of components as before.

Similar colour reactions and precipitates have been observed when cobaltous salts are added in alkaline aqueous solution to other purine and pyrimidine bases (guanine, uracil, xanthine, hypoxanthine), the nucleoside adenosine, and to solutions of thymonucleic acid.

Such a cobalt–adenine compound appears to be of special interest in view of the results of Bosworth Brown *et al.*[5] with nitrogen-marked adenine, which showed that adenine added to the diet of rats is incorporated as such in the cellular nucleic acid. This might afford a possibility of intracellular fixation of a strongly emitting radioisotope with the view of effecting selective irradiation.

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Triad Prototropic Systems

In previous publications[1], it was shown that the degradation of α-amino-acids with certain carbonyl compounds proceeds through the intermediate formation of an azomethine carboxylic acid (I), which is decarboxylated to the mesomeric anion (II). The liberated proton on recombination can attack either of the two possible positions (*a*) or (*b*) [see (II)] leading to a mixture of the two tautomerides, (III) and (IV), which on hydrolysis give rise to two carbonyl compounds.

$$R{-}CHO + R'{-}CH(NH_2)\,.\,COOH \rightarrow R\,.\,CH{=}N{-}\underset{\displaystyle R'}{\underset{|}{CH}}\,.\,COOH \xrightarrow{-CO_2}$$

I

$$R{-}\overset{(b)}{CH}{-}\overset{\ominus}{N}{-}\overset{(a)}{CH}{-}R' + \overset{+}{H} \rightleftharpoons$$

II

$$R\,.\,CH{=}N{-}CH_2{-}R' \xrightarrow{H\,.\,OH} R\,.\,CHO + R'\,.\,CH_2\,.\,NH_2$$

III

$$R\,.\,CH_2{-}N{=}CH{-}R' \xrightarrow{H\,.\,OH} R\,.\,CH_2\,.\,NH_2 + R'\,.\,CHO\,.$$

IV

I concluded from the results that such a prototropic change is facilitated by the following factors: (1) the attachment of the carbonyl group to an electron-attracting group which exhibits its maximum effect when it is directly attached to or conjugated with the carbonyl group; thus, the yield of acetaldehyde produced by the action of *o*- and *p*-nitrobenzaldehyde was found to be greater than that produced by the action of *m*-nitrobenzaldehyde[1a]; (2) the presence of a nucleophilic reagent, such as pyridine, which enhances the decarboxylation of the azomethine carboxylic acid (I) to the mesomeric anion (II); thus, the amount of the liberated carbonyl compound increased enormously when 50 per cent glycerol was replaced by 75 per cent pyridine.

In most cases, such a prototropic change could not be effected when the amino-acid was replaced by the corresponding amine. This is in accordance with the known fact that azomethine systems are immobile[2], and they become tautomerized only in presence of strong nucleophilic reagents such as sodium ethoxide[3].

In the present investigation, the results proved the validity of the above assumption. Thus, when alanine and α-aminophenylacetic acid were heated with 75 per cent pyridine on a water-bath or refluxed in 50 per cent glycerol for 3 hr. with 2 : 5-dichlor-,

2-choro-5-nitro-, 2:4-dinitro-, 2:4:6-trinitrobenzaldehyde, or isatin, they were converted into acetaldehyde and benzaldehyde respectively.

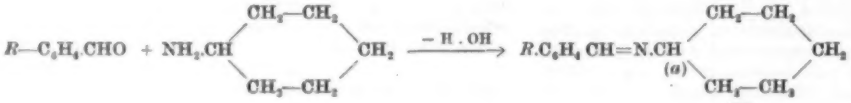
Although the interaction between *p*-hydroxybenzaldehyde and α-aminophenylacetic acid, in 75 per cent pyridine on a boiling water-bath for 3 hr., gave traces only of benzaldehyde, the yield greatly increased when the heating was carried out in boiling pyridine (3 hr.) or in quinoline at 160–170° for ½ hr. Under similar conditions, α-aminophenylacetic acid alone was not converted into benzaldehyde.

This showed that although a hydroxyl group is electron-repelling when attached to an aromatic nucleus, and, therefore, will inhibit the tendency for the decarboxylation of the azomethine carboxylic acid (I), yet the use of more drastic conditions (high temperature of the bath) facilitated the decarboxylation to the mesomeric anion (II).

When the hydroxyl group is attached to a saturated aliphatic chain, it acts as an electron-attracting group (I), and therefore it would be expected that saturated aliphatic hydroxyaldehydes, such as glyceraldehyde and glucose, are capable of effecting the degradation of α-amino-acids.

When α-amino-*m*-nitrophenylacetic acid was heated with *o*- and *m*-chlorobenzaldehyde in pyridine on the water-bath, it was partially converted into *m*-nitrobenzaldehyde.

When *o*-, *m*-, *p*-nitro- and *o*-, *m*-chlorobenzaldehyde were heated with alanine ester or α-aminophenylacetic ester in pyridine for three hours on a water-bath, practically no acetaldehyde or benzaldehyde, respectively, was obtained. Under similar conditions amines such as ethylamine, benzylamine and *cyclo*hexylamine were not converted into the corresponding carbonyl compounds (that is, acetaldehyde, benzaldehyde and *cyclo*hexanone, respectively). However, although stronger degrading agents such as isatin, 2 : 4-dinitro- and 2 : 4 : 6-trinitrobenzaldehyde were able to effect the conversion of ethylamine and benzylamine into acetaldehyde and benzaldehyde respectively, they failed to convert *cyclo*hexylamine into *cyclo*hexanone. This is an interesting result, since 1-amino-*cyclo*hexane-1-carboxylic acid is easily degraded to *cyclo*hexanone even with weak degrading agents such as *p*-nitro- and *o*-chlorobenzaldehyde[1b]. However, it may be due to the increase in the electron density created by the electron-repelling CH_2 groups on the carbon atom (*a*) of the azomethine (IV), which makes it very difficult to extract the proton from this carbon atom. Thus, no prototropic change will be possible under normal conditions.



When *p*-hydroxybenzylidenebenzylamine was refluxed with pyridine for three hours, it failed to give any benzaldehyde. However, traces of it were obtained when the heating was carried out in quinoline at 160–170° for half an hour.

The above reactions were carried out in a carbon dioxide atmosphere, and when pyridine or quinoline was used as a medium, the reaction mixture was acidified with hydrochloric acid and the liberated carbonyl compounds steam-distilled.

A quantitative study of the extent of the prototropic change is now under investigation.

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Role of the Solvent in Reduction with Lithium Aluminium Hydride

Since the discovery of lithium aluminium hydride[1], it has been used for a variety of reductions[2]. Its reactions are normally those of hydride anions, and in the type of compound with which it reacts there is a far-reaching analogy with the Grignard reagent. The mechanism of the reaction has been investigated by Trevoy and Brown[3], who concluded from a wide range of evidence that the rate-determining step is a bimolecular nucleophilic substitution by a hydride ion, possibly complex.

This mechanism ignores the solvent, and it is the purpose of this communication to show that ether plays an essential part in the reaction, and to suggest how the above mechanism, which must be broadly true, may be modified to take account of its action.

The presence of ions in the ethereal solution of lithium aluminium hydride has now been proved directly; the specific conductivity of a molar solution was $(4{\cdot}43 \pm 0{\cdot}02) \times 10^{-5}$ ohm^{-1} cm.$^{-1}$ at 15° C., which may be compared with that of a molar solution of ethyl magnesium bromide at 20° C. ($6{\cdot}14 \times 10^{-5}$ ohm^{-1} cm.$^{-1}$) [4].

The reduction of three covalent halides, phosphorus trichloride, boron trichloride and silicon tetrachloride, was studied. The reaction of phosphorus trichloride with lithium aluminium hydride in ether is rapid below 0° C., and may be used to prepare phosphine in good yield. In the experiment reported here, phosphorus trichloride was heated under reflux in absence of ether for one hour at 75° C., with a 0·25 per cent yield of phosphine. Boron trichloride treated similarly gave no detectable quantity of volatile boron-containing material; on adding ether, a violent reaction to give diborane took place at the melting-point of ether. In another experiment, silicon tetrachloride heated under reflux with lithium aluminium hydride for one hour gave a negligible yield of silane. Ether was added at − 196° C., and as the temperature reached the melting point of ether a rapid evolution of silane (yield 96 per cent) ensued.

On the other hand, in qualitative experiments with acetone and benzonitrile (both compounds having donor properties), reduction took place without the addition of ether. The analogy with the Grignard reagent thus extends to the necessity for a donor solvent; evidence for a mono-etherate stable below 0° C. has been obtained.

As an explanation of the action of the ether, it is suggested that there is an equilibrium in solution:

$$AlH_4^- \rightleftharpoons H^- + AlH_3,$$

and that the function of the ether is to co-ordinate with the aluminium hydride and drive the equilibrium to the right-hand side. It is known independently that aluminium hydride retains ether tenaciously[1].

This explanation implies that the active entity is the H^- ion rather than the AlH_4^- ion; this is being tested both by examining the effect of added aluminium hydride on the reactivity of lithium aluminium hydride solutions, and by transport experiments designed to determine the nature of the ions present.

Thanks are expressed to Prof. H. J. Emeléus and Dr. A. G. Sharpe for interest and help, and Messrs. Albright and Wilson, Ltd., for generous support.

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Intracrystalline Water in Pollucite

The natural mineral pollucite is generally formulated as $(Cs,Na)_2O.Al_2O_3.4SiO_2.H_2O$. It is isostructural with analcite, $Na_2O.Al_2O_3.4SiO_2.2H_2O$, both having cubic unit cells. Values of a reported for analcite range from 13·6$_8$ A. to 13·6$_7$ A.[1], and for pollucite from 13·6$_8$ A. to 13·6$_9$ A.[2].

The distribution of the water molecules in the pollucite structure raises an interesting point. According to W. H. Taylor[3], there are 24 available sites in the analcite unit cell for the 16 sodium ions, each sodium ion lying between four oxygen atoms of the framework and two water molecules. To preserve cubic symmetry, the sodium ions must be randomly distributed. The cations in the identical aluminosilicate framework of pollucite must be similarly distributed. The question then is whether the water molecules in the crystal are associated only with the sodium ions or may also be located in the vacant sites of the framework, of which there are just enough to accommodate the amount of water given in the above formula[1]. In order to decide this point, the following observations have been made.

The water content of some natural pollucites appears to decrease with decreasing sodium content and increasing cæsium content[4]. This suggests that the water may be associated only with the sodium ions; but a final proof can be offered only by synthesizing a pure cæsium pollucite and demonstrating that it is anhydrous. This synthesis has now been carried out by us, using cæsium aluminosilicate gels in hydrothermal systems. (Details of the preparation of synthetic pollucites will be given elsewhere; the mineral has also been grown by the recrystallization of chabazite[1].) The synthetic pollucite of composition $Cs_2O.Al_2O_3.4SiO_2$ has been found to be an anhydrous species. No water is then associated with the 8 vacant sites per unit cell. The correct formula for pollucite will then be $(Na_xCs_{1-x})_2O.Al_2O_3.4SiO_2.2xH_2O$.

The identity of the unit cell as between analcites and pollucites requires that, so far as occupation of the interstitial cavities in the identical aluminosilicate framework of these crystals is concerned, $(Na^+ + H_3O)$ is equivalent to Cs^+. By contrast, the anhydrous crystals in which, through ion exchange, the smaller units K^+, Rb^+ and Tl^+ replace $(Na^+ + H_3O)$ in analcite have slightly distorted anionic frameworks[1]. However, unlike sodium, rubidium and thallium ions, the cæsium ion is too large to migrate from one interstitial site in the crystals to the next, so that the framework exhibits an ion-sieve effect towards the cæsium ions, and this ion when incorporated during crystal growth is locked into the crystal[1]. The distribution of the 16 cæsium ions among the 24 equivalent sites per unit cell can be random in space but not in time. The mobile cations sodium, rubidium and thallium, on the other hand, may be randomly distributed in time and space. The size and immobility of the cæsium ions would then appear to explain the known difficulty in dehydration and rehydration of pollucites containing some sodium, when compared with analcite, since water molecules can escape from or enter the crystals only along the channels occupied by the cations. Dehydration of pollucite requires temperatures as high as 640° C. before completion, and rehydration involves heating the crystals in an autoclave with water at 400–500° C.[2].

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A Delicate Chromatograph Test for the Presence of Moisture in Alcohol

It has been found in this laboratory that paper-strip ascending chromatography affords a simple means of detecting small quantities of water (of the order of 0·1–5 per cent) present in alcohol.

The principle employed is to allow the alcohol to ascend a test paper strip (approximately 3/16 in. × 4½ in.) passing through two previously prepared zones, the lower being impregnated with iron sulphate and the upper with potassium ferricyanide. Neither of these salts is alcohol-soluble but both are water-soluble; consequently, if the ascending alcohol contains water, iron sulphate will be eluted from the lower zone and carried to the upper, with the production of ferric ferrocyanide, visible as a band of Turnbull's blue. The extent and intensity of coloration depend on the amount of water present. If a pencil mark, say, 2 in. above the beginning of the upper zone, is used as the standard height of alcohol ascent, the method becomes quantitative after calibration runs with alcohol containing known amounts of added water.

At low concentration of water, the blue colour may not be apparent until the test-strip has been air-dried.

Of the various papers tried, 'Devon Mills' white blotting has been the most satisfactory. Solutions: lower zone, 3 per cent in water; upper zone, 1 per cent in water.

Application is made with a glass tube of about ⅛-in. bore drawn down in a flame to give a smooth

rounded end having an orifice about 1/32 in. diameter. The tube, containing approximately 2-in. length of the sulphate solution, is drawn along the edge of a blotting paper sheet cut to 4½ in. × 12 in., so as to make a band ¼–5/16 in. wide, leaving a ½-in. margin approximately; the second solution is applied in a similar manner, a little higher up, leaving a gap of about ½ in. between it and the first band. The paper is then air-dried and cut into strips 3/16 in. wide and stored in an air-tight container with a mild drying agent (silica-gel capsule). This is desirable, as in damp weather the method is sensitive enough to react to the trace of moisture picked up from the atmosphere by the test strips.

I am indebted to the manager of this laboratory, Lieut.-Commander J. R. D. Walker, for permission to make this communication.

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Determination of Reaction-rates by Conductivity Measurements

Among the reactions which have proved of value in the investigations of the effects of substituents on reaction-rates in solution is the one between organic chlorides and metallic iodides in acetone. This reaction, which was first investigated kinetically by Conant and Kirner[1], is suitably free from complicating side reactions, and the very low solubility of potassium chloride in acetone ensures that it goes almost to completion. It has, therefore, been extensively used in kinetic studies by Conant, Bennett and others.

Hitherto, the progress of the reaction has been followed by estimating the unreacted inorganic iodide by titration methods. Foremost among such methods is the one developed by Bennett and Berry[2], and based on the observation of Lang[3], that the addition of an oxidizing agent, such as potassium iodate, to an acid solution of a metallic iodide in the presence of hydrogen cyanide, converts the liberated iodine into iodine cyanide, a form which does not colour starch. Unfortunately, the presence of acetone in the titration mixture makes it difficult to determine the end-point, and it is necessary to remove it before the iodide can be determined accurately. The procedure is therefore a little laborious, and when a large number of halides are examined it becomes tedious.

In these circumstances it is natural to look for a simpler method of following the course of the reaction, particularly since an extensive study is being made of the influence of two or more substituents on the reactivity of benzyl halides and related compounds. The fact that potassium chloride is precipitated, and that ions are therefore removed from solution, suggests that the reaction may be followed satisfactorily by measuring the electrical conductivity of the reaction mixture. This proves to be the case. Although the procedure used so far is capable of refinement, the publication of a similar conclusion by Evans and Hamann[4] prompts us to report some of the results obtained. In the accompanying table the values found in an earlier investigation by a volumetric method are compared with the first values obtained by the conductivity method.

Rate Constants for the Reaction between Substituted Benzyl Chlorides and Potassium Iodide in Acetone

Substituent	Volumetric (ref. 5) $k_{25°}$	Conductometric
p—Cl	2·80	2·89
o—NO_2	11·4*	12·1

* The reaction in this case is rapid, and therefore is determined less readily.

In these measurements the molecular ratio of organic chloride to potassium iodide is 5 : 1, but it is advisable to reduce this ratio and so minimize any risk that the organic halide might affect the determinations.

Refinements in technique are being made which should enable the rates to be determined accurately and expeditiously. With the benzyl chlorides a greater accuracy in measurement is particularly important, since variations in entropy and in activation energy may be rather small, and their significance might easily be masked by experimental errors.

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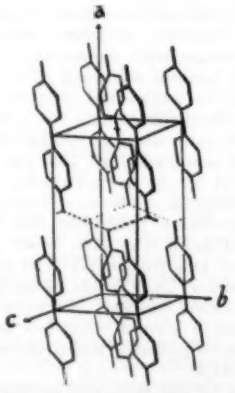
Crystal Structure of 4′4′-Dihydroxydiphenyl

Crystals of 4′4′-dihydroxydiphenyl can be obtained as thin plates from alcohol–water solution or by sublimation. By optical and X-ray examination, they are found to be monoclinic with the *b*- and *c*-axes in the plane of the plate. The unit cell constants are: $a = 10{\cdot}54 \pm 0{\cdot}05$ A., $b = 5{\cdot}36 \pm 0{\cdot}02$ A., $c = 7{\cdot}95 \pm 0{\cdot}05$ A., $\beta = 95° 30' \pm 1°$. The space group is $P2_1/c$, and since there are only two molecules in the unit cell (calculated from a density of 1·380 gm./c.c.) they must lie in special positions such that molecular centres of symmetry coincide with the centres of symmetry in the cell. Although there are other ways in which this condition might be satisfied, such as by free rotation about the central C—C bond, or rotation of the molecule as a whole in the crystal,



Structure of 4′4′-dihydroxydiphenyl

the obvious inference is that the molecule is centrosymmetric by having its two aromatic rings coplanar.

A trial structure was obtained by building a scale model with planar molecules having their centres at 000 and $0\frac{1}{2}\frac{1}{2}$. The proposed arrangement was confirmed by a two-dimensional Fourier summation based on the intensities of $hk0$ reflexions visually estimated on Weissenberg photographs. The structure consists of layers parallel to the $(\bar{1}02)$ plane with the 0—0 axis of each molecule tilted slightly out of this plane, but parallel to (010). Within each layer the molecules are linked as shown in the accompanying diagram by zig-zag chains of weak hydrogen bonds (each of length 2·9 A.) between their hydroxyl groups. There is no bonding between the layers. The packing of the molecules, apart from the linking through hydrogen bonds, is very similar to that found in crystals of diphenyl[1] and other aromatic hydrocarbons. A more detailed investigation of the structure is being made.

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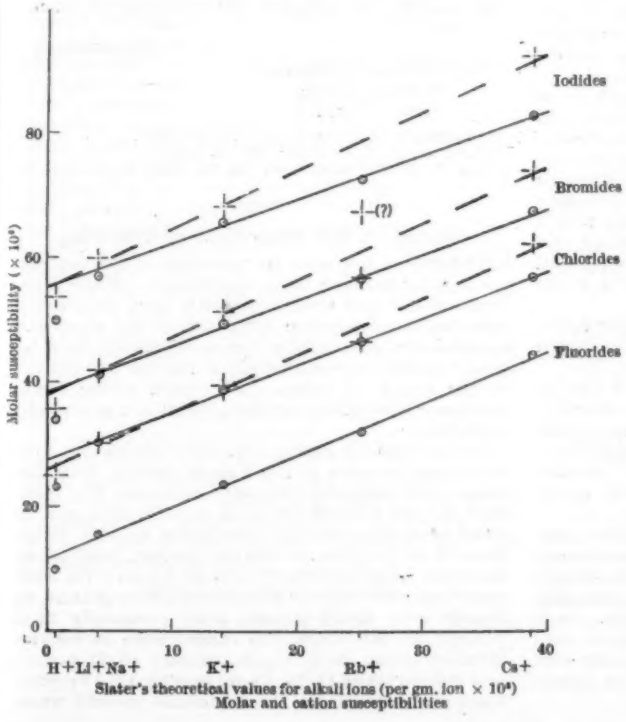
Magnetism of Hydrogen and Lithium Ions

In the free state, the hydrogen ion, H^+, can clearly exhibit no magnetism, and the lithium ion, Li^+, will possess a small diamagnetism. It has often been pointed out that, in solids or in solutions, these ions should not behave in this fashion, but would most likely give rise to a paramagnetic effect in addition.

Molar values of the diamagnetic susceptibilities of the alkali halides, obtained from Brindley and Hoare's[1] measurements for these compounds in the powdered crystal state, have been plotted in the accompanying diagram as a function of free cation susceptibility as predicted by Slater's[2] theory (values for cation susceptibilities have been re-calculated, using more reliable data for the fundamental constants e, m_e, c and N than was available at the time of Slater's work). If the susceptibilities of ions are additive and there is no variation with chemical combination, then all points representing chlorides, for example, should lie on a straight line. It is immediately apparent that the representative points for the lithium halides lie consistently below their respective straight lines. It might be argued that, as there is no positive proof of the reliability of Slater's theoretical values, such a procedure is unjustified. However, it is clear that, even were the Slater figures greatly in error, the same conclusion must be reached.

The interpretation is that the lithium ion is producing a paramagnetic effect equal to the ordinate separation between point and line. For the halide lines (except fluoride), these separations are close in size, the average being 4·9, thus giving for the susceptibility of the lithium ion: $(-0{\cdot}7 + 4{\cdot}9) = +4{\cdot}2$ $(\times 10^{-6})$. Again, Slater's theoretical value for the lithium ion $(-0{\cdot}7)$ has been employed, but the probable error incurred by this is negligible.



Slater's theoretical values for alkali ions (per gm. ion × 10^6)
Molar and cation susceptibilities

When the mean values are plotted of molar susceptibilities for the alkali halides in aqueous solution, obtained from measurements by a large number of different workers, similar results are obtained. Measurements for halide acids are included, and these show an even stronger paramagnetic effect for the hydrogen ion as compared with lithium. Mean deviations from linearity are: H^+, 4·5; Li^+, 2·1; giving effective ionic susceptibilities of $H^+ = +4{\cdot}5$ and $Li^+ = (-0{\cdot}7 + 2{\cdot}1) = +1{\cdot}4$ for these ions in aqueous solution.

By comparison of diamagnetism with refraction, Weiss[3] predicted exactly this kind of paramagnetic effect for small cations dissolved in polar solvents. Weiss suggested paramagnetic effects of 1·1 and 0·9 for the hydrogen and lithium ions respectively. The figure for hydrogen is much less than is suggested here; but since there is no way of determining ionic refractivities theoretically with the same reliability as ionic diamagnetic susceptibilities, it is likely that the Weiss figure is incorrect.

Brindley and Hoare[4], by yet another method, have also deduced paramagnetic effects for H^- and Li^+, and give $+3{\cdot}8$ and $+0{\cdot}3$ respectively for their effective susceptibilities in solution. These figures are in fair agreement with the analysis made here.

I wish to express my thanks to Prof. A. M. Taylor for his interest in this work.

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Mineral Separation by an Electrochemical-Magnetic Method

A simple method has been devised for the separation of minerals with a relatively high electrical conductivity in rock powders. It is based on the selective deposition upon these minerals of metallic iron, in an electrolytic cell, enabling them to be separated from the non-conducting grains with a magnet.

About 5–10 gm. of crushed sample, having passed a 100-mesh sieve, or finer if necessary, to avoid composite grains, is spread on the bottom of a flat-bottomed iron can of 7–10 cm. diameter and 7 cm. height, which is made the cathode and also serves as container for the electrolyte, a strong solution of ferrous chloride with calcium chloride. A disk of sheet iron of somewhat less diameter, attached to a vertical iron rod, serves as anode, and the interior wall of the can should be varnished to restrict electrodeposition to the floor.

A source of direct current, up to 10 amp. at 6 V. or more, such as a lead battery, is connected to the cell, preferably with an ammeter and appropriate variable resistor in series, so that the current density may be varied and controlled. A current density of 0·05 amp./cm.^{2} of area covered by the sample gives ample coating of iron in three or four minutes, and may be raised to a much higher figure if necessary, when adequate iron deposition is almost instantaneous. During the passage of the current the grains should be gently moved about, and for mixtures with a very low content of conducting grains a longer period of deposition is required. After washing and drying the mixture, the coated grains are separated with a magnet, and treated with dilute acid to remove the iron.

The method may be made to yield quantitative results, and the apparatus and conditions adjusted to larger or smaller amounts of sample.

Examples of clean separations of minerals used in these experiments, behaving as conductors and non-conductors respectively, were: pyrite, galena, copper sulphide ores, native metals, graphite, arsenopyrite; and quartz, silicates, barite, wolframite, apatite, rutile, zircon, hæmatite, ilmenite, cinnabar, sphalerite, manganese ores.

The method has application in the common case where the specific gravity of the several constituents is too high for heavy-liquid separation, and the electrostatic and dielectric methods, froth flotation, panning, or selective chemical attack are inadequate. It is of particular value when the mineral sought, conductive or non-conductive, forms the only one with this property in the rock, when it may be quantitatively isolated.

It is hoped to publish a fuller account of the method elsewhere.

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The Carotid Labyrinth of *Rana tigrina*

Hollinshead[1] demonstrated with the Severinghaus staining technique the presence of fuchsinophil granules in the cytoplasm of the carotid-body cells in the cat. Later on[2], he showed that these granules disappear from the mouse carotid-body cells in cases of lethal anoxia. Hollinshead related this disappearance tentatively with the state of activity of the carotid-body cells, as it is known that anoxia stimulates powerfully the release of nerve impulses in this organ.

Using the same staining techniques, we were able to detect cells, in the carotid labyrinth of *Rana tigrina*, which show a great resemblance to the mammalian carotid-body cells, and which likewise contain fuchsinophil granules. These cells occur sparingly and only in the pars arterialis.

In two frogs killed by anoxia, these cells were found to be entirely devoid of the fuchsinophil granules.

This finding may help to clarify the functional role of the carotid labyrinth in Amphibians, and may throw further light upon the evolutionary development of the carotid body in reptiles, birds and mammals. So far, no direct evidence exists that the amphibian carotid labyrinth corresponds to the mammalian carotid body. Palme[3] considered it as a pressor receptive zone only, while the present study may indicate in addition the existence of chemoreceptors.

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Boron in the Nutrition of the Hop

The role of boron in the nutrition of the hop does not appear to have been determined. While many horticultural and field-crops have been reported to demonstrate distinctive symptoms in the absence of a sufficiency of available boron, singularly little has been reported on the reaction of the hop to variation in the supply of boron. No report giving boron-deficiency symptoms has been found in the available literature.

In the 1949–50 season, samples of leaves and cones from hops growing in the Nelson district, New Zealand, were analysed for boron content. For leaves from the top third of the plant in gardens on soils derived from Moutere Hill, the boron content ranged from 31 to 70 p.p.m. in the dry matter, most values, however, lying between 36 and 42 p.p.m.; for corresponding material from soils derived from granite, the figures were 12–36 p.p.m., most commonly 21–28 p.p.m. In the cones, the ranges were as follows: Moutere types, 14–22 p.p.m. (mostly 16–21 p.p.m.), and granite types 13–24 p.p.m. (mostly 13–17 p.p.m.). Samples of soil from these gardens showed water-

Hop shoots showing distorted leaves and death of the growing points due to deficiency of available boron

soluble boron contents of 0·25–0·73 p.p.m. on the dry basis. There appeared to be no close relation between *p*H value or available boron content of the soil and the boron content of leaves or cones. The data for leaves and cones suggested, however, that the boron supply in some gardens might be sub-optimal.

Most of the 1950–51 growing season was extremely dry, and after the early pruning of the plants many gardens showed very unsatisfactory growth. There was great delay in the development of new shoots, accompanied by a crinkled condition, often sufficient to cause malformation, of the leaves. Shoots showed short internodal spacing, development of secondary laterals at an early stage, and dying of the growing point. Incidence of these defects varied greatly from garden to garden, but it was unusual to find a garden free from one or other of these symptoms. Replants were, however, commonly free from this undesirable type of growth. Severity of symptoms varied from point to point within a garden or on a given soil type. Examinations made as late as mid-January 1951 revealed that symptoms were still visible on young basal or late growth shoots.

When boron deficiency in raspberries in the Nelson district was being investigated in 1948, certain rows in two hop gardens were treated with borax at the rate of ½ oz. per hill. It was most noticeable this season (1950–51) that plants in these treated rows were healthy and grew normally. This, together with the field distribution of the untoward behaviour of the plants in the remainder of these two gardens, suggested that the unsatisfactory growth conditions in the gardens were due to a deficiency of boron. Samples of young shoots from the above gardens gave the following analytical data :

BORON (P.P.M. ON THE DRY BASIS)

Location	Unhealthy	Apparently healthy (not treated with borax)	Healthy (treated with borax)
Wai-iti	7·5	16·3	50·4
Tadmor	9·5	18·4	34·2

These figures suggest that the supply of boron for the unhealthy plants was sub-optimal. Further samples from other gardens gave, for five direct comparisons : unhealthy, 9·6 p.p.m. ; apparently healthy, 16·6 p.p.m. For two definitely affected gardens the average figure was 15·6 p.p.m., and for two nearly healthy gardens, 26·4 p.p.m. The lowest figure so far found has been 2 p.p.m. for a garden with only 13 per cent of apparently healthy plants and 37 per cent of hills apparently dead. These data confirm the suggestion that the unsatisfactory growth was due to a deficiency of available boron. From the limited data of this season's survey, it would appear that for healthy growth hop shoots should contain not less than 20 p.p.m. of boron in the dry matter.

The hop, therefore, may now be included among those plants demanding a certain level of supply of boron for healthy growth, and the absence of which leads to distinctive symptoms in the vegetative parts of the plant.

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A Unit of Wave-number

In *Nature* of April 21, Mr. C. Candler puts forward the suggestion that a convenient, practical unit should be introduced for recording wave-numbers. Such a unit would certainly be welcome ; but was not the name 'Balmer' suggested several years ago to denote the reciprocal of the Ångström unit ? I regret that at the moment I am unable to locate the reference.

In any event, the use of the name 'Balmer' seems to me justified from the historical point of view. As a matter of fact, Balmer, who was a secondary school teacher in Basle, made the first important contribution towards establishing the relationship between the wave-lengths of certain of the lines of the hydrogen spectrum. In comparison with these fundamental findings, the introduction of wave-numbers instead of wave-lengths seems of minor importance. Rydberg has already been suitably honoured in giving his name to the constant. On the other hand, the name of Balmer is commemorated only by the 'Balmer series', suggesting that his work was on no higher level than that of Lyman, Paschen, Brackett, etc. In fact, however, Balmer was a pioneer in this field and is entitled to greater recognition.

The unit 'balmer', conveniently abbreviated to 'B', could, of course, likewise be used to replace 'cm.$^{-1}$', as proposed by Candler in the case of the unit 'rydberg'.

W. Bladergroen

Sandoz Ltd.,
Basle.

An agreed unit is far more important than the name chosen. 'Balmer' seems as suitable as 'Rydberg', though I have never met the 'Balmer' in the literature. A choice would best be made by an official body the decision of which would be generally accepted.

C. Candler

Canynge Hall,
University of Bristol,
Bristol 8.

FORTHCOMING EVENTS

Tuesday, July 3

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre, New Physics Building, The University, Manchester), at 11 a.m.—Prof. Leon Rosenfeld: "Joule's Scientific Outlook"; at 2.45 p.m.—Opening of the Joule Museum at Joule House, Acton Square, Salford, by Alderman John Brentnall.

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Dr. P. A. Theron: "Some Problems of Industrial Psychology in South Africa".

Tuesday, July 3—Friday, July 6

BRITISH INSTITUTION OF RADIO ENGINEERS (in the Anatomy Lecture Theatre, University College, Gower Street, London, W.C.1).—Radio Conference, Sessions 1 and 2: Electronic Instrumentation and Valve Technology. (No further tickets are available.)

SOCIETY FOR APPLIED BACTERIOLOGY (at Marischal College, Aberdeen).—Annual General Meeting and Conference.

Thursday, July 5—Saturday, July 7

PHYSICAL SOCIETY (in the Physics Department, Queen's University, Belfast).—Summer Provincial Meeting.

Friday, July 6

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, POLAROGRAPHIC DISCUSSION PANEL OF THE PHYSICAL METHODS GROUP (at the British Oxygen Co., Ltd., Morden Factory Estate, Morden Road, London, S.W.19), at 4.30 p.m.—Discussion on "Polarography in Trace Analysis".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT EDUCATIONAL PSYCHOLOGIST for advisory work in the schools and clinical work in the Child Guidance Service—The County Education Officer, The Castle, Winchester (July 6).

SENIOR SCIENTIFIC OFFICER (with an honours degree in botany or agricultural botany or its equivalent, and a sound knowledge of the principles of genetics and practical plant breeding) in the Plant Breeding Division of the Ministry of Agriculture—The Secretary, Civil Service Commission, Stormont, Belfast (July 6).

ASSISTANT LECTURER IN CHEMISTRY, and an ASSISTANT LECTURER IN METALLURGY—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (July 7).

ASSISTANT LECTURER (Grade A) IN PHYSICAL CHEMISTRY, and an ASSISTANT LECTURER (Grade B) IN METALLURGY, at the Constantine Technical College, Middlesbrough—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (July 7).

ASSISTANT PHYSICIST at the Radiotherapy Centre, Queen Elizabeth Hospital—The Secretary, United Birmingham Hospitals, Queen Elizabeth Hospital, Birmingham 15 (July 7).

CHEMISTS and CHEMICAL ENGINEERS at Ministry of Supply Research and Development Establishments near London: ORGANIC CHEMISTS with experience of synthetic research work and modern methods of organic analysis, an ANALYTICAL CHEMIST for the development of new chemical testing methods (experience with explosives essential), PHYSICAL CHEMISTS with experience of plastics, rheology, colloids, kinetics or instrumentation, CHEMICAL ENGINEERS with experience in plant development and design, a PLANT CHEMIST with experience in the control of processes involving high and low pressure gases, CHEMISTS with experience of gas analysis, of gaseous reactions under laboratory conditions, or of the control of gases on an industrial scale, and CHEMISTS with experience in examination of water and sewage effluents—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.375/51A (July 7).

DEMONSTRATOR IN APPLIED PSYCHOLOGY in the Department of Psychological Medicine, King's College Medical School and Royal Victoria Infirmary—The Registrar, King's College, Newcastle-upon-Tyne (July 7).

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY, and a LECTURER IN GENERAL CHEMISTRY, at the Rutherford College of Technology, Newcastle-upon-Tyne—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (July 7).

LECTURER IN PHONETICS, and a LECTURER IN LINGUISTICS—The Secretary, School of Oriental and African Studies, University of London, London, W.C.1 (July 7).

POMOLOGIST, and a PHYSICAL CHEMIST, in the Section of Insecticides and Fungicides, Long Ashton Research Station—The Registrar and Secretary, The University, Bristol (July 7).

PERREN CHAIR OF ASTRONOMY at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 9).

ASSISTANT for the teaching of Chemistry and either Physics or Mathematics in the College Secondary School—The Principal, Wigan and District Mining and Technical College, Wigan (July 10).

ELECTRICAL ENGINEERS and PHYSICISTS (Senior Scientific Officer or Scientific Officer grade) at Ministry of Supply research and development establishments near London: ELECTRICAL ENGINEERS qualified in radio communications with an interest in the engineering of development prototypes, a PHYSICIST with experience in electronic circuitry problems for measurement of high speed transients, an EXPERIMENTAL PHYSICIST with experience of metallurgical problems, and a PHYSICIST with interest in application of electronic methods to optical instrumentation techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.162/51A (July 13).

ENGINEER I at a Ministry of Supply establishment in south-east England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.230/51A (July 13).

NORTH THAMES GAS BOARD GAS RESEARCH FELLOWSHIP for research in relation to carbonization, gaseous fuels and combustion—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (July 13).

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CHAIR OF APPLIED MATHEMATICS—The Registrar, University College of Wales, Aberystwyth (July 14).

HERDMAN POSTGRADUATE STUDENTSHIP IN MARINE ZOOLOGY—The Registrar, The University, Liverpool (July 14).

LECTURER IN BACTERIOLOGY—The Secretary, King's College Hospital Medical School, Denmark Hill, London, S.E.5 (July 14).

LECTURER IN BIOCHEMISTRY—The Registrar, University College of Wales, Aberystwyth (July 14).

RADIO ENGINEER (with industrial experience or service in a research establishment) by a Government Department—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.260/51A (July 14).

RESEARCH DEMONSTRATORS (2) IN PHYSICS—The Registrar, University College of South Wales, Cathays Park, Cardiff (July 14).

SENIOR LECTURER IN ANIMAL HUSBANDRY in, and a SENIOR LECTURER IN THE CLINICAL DEPARTMENT of, the University Veterinary School—The Secretary of University Court, The University, Glasgow (July 14).

TEACHER IN THE CHEMISTRY DEPARTMENT, to teach Inorganic Chemistry, at Widnes Municipal Technical College—Mr. W. R. Wainwright, Education Office, Lugsdale Road, Widnes (July 14).

ASSISTANT PROFESSOR OR ASSOCIATE PROFESSOR OF GROSS ANATOMY at Queen's University Medical College, Kingston, Ont., Canada—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 15).

SENIOR RESEARCH OFFICER to take charge of the Heat Section in the National Physical Laboratory, Pretoria—The Secretary/Treasurer, Council for Scientific and Industrial Research, P.O. Box 395, Pretoria, South Africa (July 31).

ASSISTANT LECTURER IN THE BIOLOGY DEPARTMENT, and an ASSISTANT LECTURER IN THE CHEMISTRY DEPARTMENT—The Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

BIOLOGIST in the Medical Department, Gold Coast, to assist with survey of schistosomiasis—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/275/51.

CHEMIST I in the Production Planning Section—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

DEPUTY WATER ENGINEER AND MANAGER—The Water Engineer and Manager, Spon House, 21 Allesley Old Road, Coventry.

DEVELOPMENT ENGINEER at the Ministry of Supply Division of Atomic Energy (Production), Research and Development Branch, Windscale Works, Sellafield, Cumberland, to be responsible for the design and ordering of plant and equipment for research and development projects and for the general supervision of the research department's workshops—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ENGINEER (Structural) in the Public Works Department, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/207.

INTERNATIONAL WOOL SECRETARIAT RESEARCH FELLOWSHIP—The Principal, Technical College, Bradford.

JUNIOR GEOLOGIST by the Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27533.E.

LECTURER IN THE DEPARTMENT OF AERONAUTICS—The Head of Aeronautics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.

LECTURER IN THE DEPARTMENT OF PHYSICS, Bradford Technical College—The Director of Education, Town Hall, Bradford.

LECTURER OR ASSISTANT LECTURER IN PHYSIOLOGY AND PHARMACOLOGY (or Physiology and Biochemistry), a LECTURER OR ASSISTANT LECTURER IN MICROBIOLOGY, an ASSISTANT LECTURER IN PHARMACEUTICAL CHEMISTRY, and an ASSISTANT LECTURER IN FOOD SCIENCE—The Secretary, Royal Technical College, Glasgow.

MECHANICAL ENGINEER in the Public Works Department, Hong Kong—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27325/16.

METALLURGIST for research in Metallurgy (General) Divisional Laboratory (at the Royal School of Mines)—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

METALLURGISTS, PHYSICISTS and PHYSICAL CHEMISTS in the Research and Development Branch (Metallurgical) of the Division of Atomic Energy (Production), at Risley, Salwick, and Sellafield, to undertake a wide range of experimental work in normal and radioactive metallurgy—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, stating post applied for.

PHYSICIST, CHEMISTS, and TECHNICAL ASSISTANTS, to undertake detailed work associated with the production programmes of three large factories—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

PLANT PATHOLOGIST in the Department of Agriculture, Jamaica, for work in connexion with the investigation and control of plant diseases generally—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27059/21.

RESEARCH FELLOWSHIPS (2) for studies on the physiology of the feet—The Director of Research, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering, Northants.

WATER SUPPLY AND IRRIGATION ENGINEERS in the Colonial Engineering Service—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/184.

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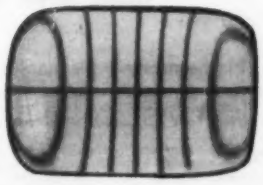

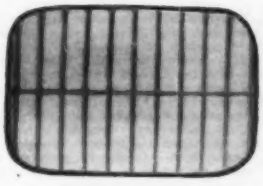

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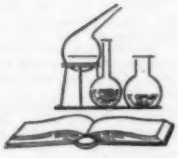

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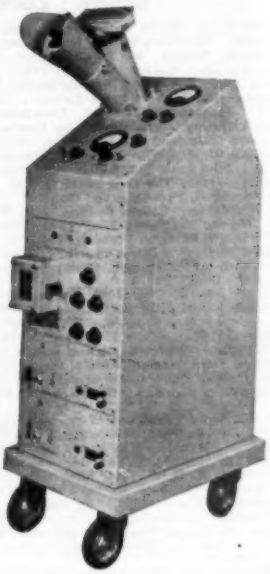

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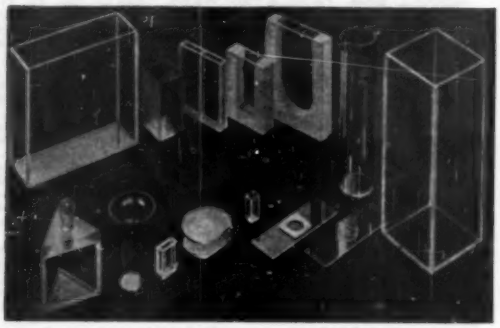

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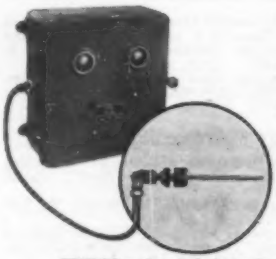

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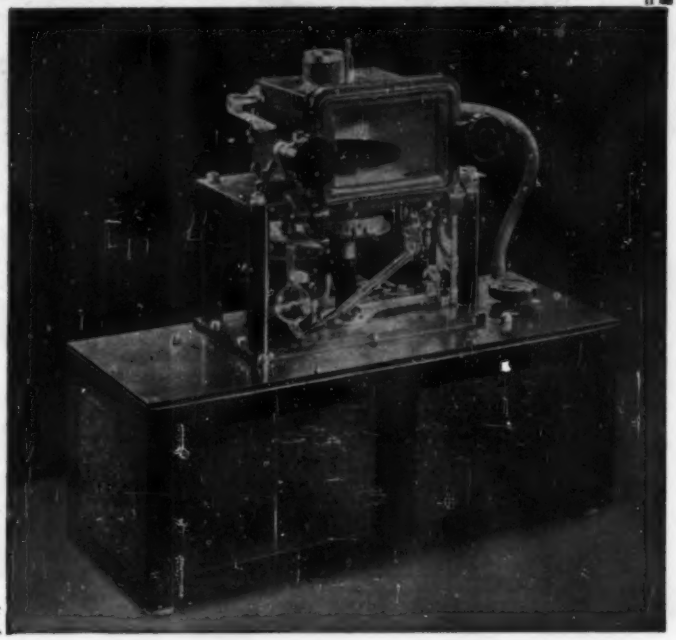

A new MINIATURE
Voltage Reference Tube

Designers of compact industrial equipments will welcome this new Mullard Miniature Voltage Reference Tube. Built on the small B7G base, it is characterised by high stability and robust construction. It should prove of great value where an extremely accurate and reliable performance, coupled with a maximum saving of space, is required. The larger version of this tube known as the 85A1 built on a B8G loctal base is also freely available.

Working in a constant current circuit, these tubes provide a voltage source of extremely high constancy, and in the majority of applications may be used to replace a standard cell as a built-in source of voltage reference. They may likewise be used as a reference against which to compare or fix the level of almost any physical quantity which is convertible into an e.m.f. Their use in this manner in position control systems, temperature control devices, etc., will thus be apparent.

VALVE DATA	
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Max. Starting Voltage	125V
Current Range	1-10mA
Preferred Operating Current	6mA
Internal Resistance at 6mA	300Ω

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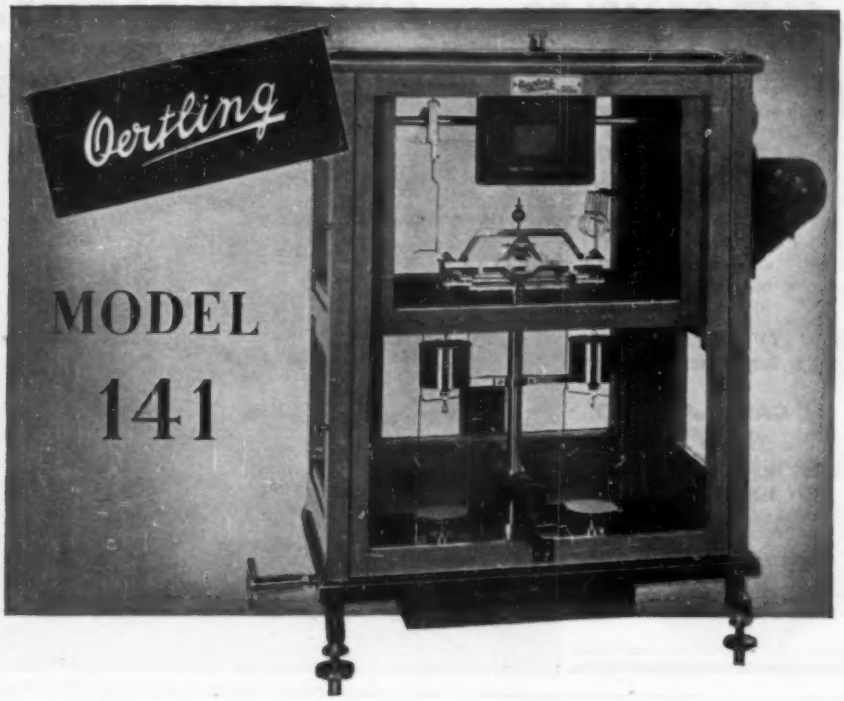
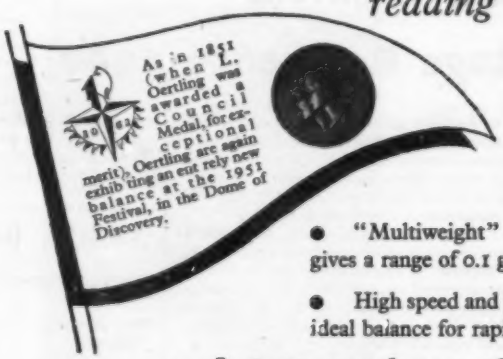


A high-speed microchemical balance reading direct to 0.01 mg.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YAS/OR/327

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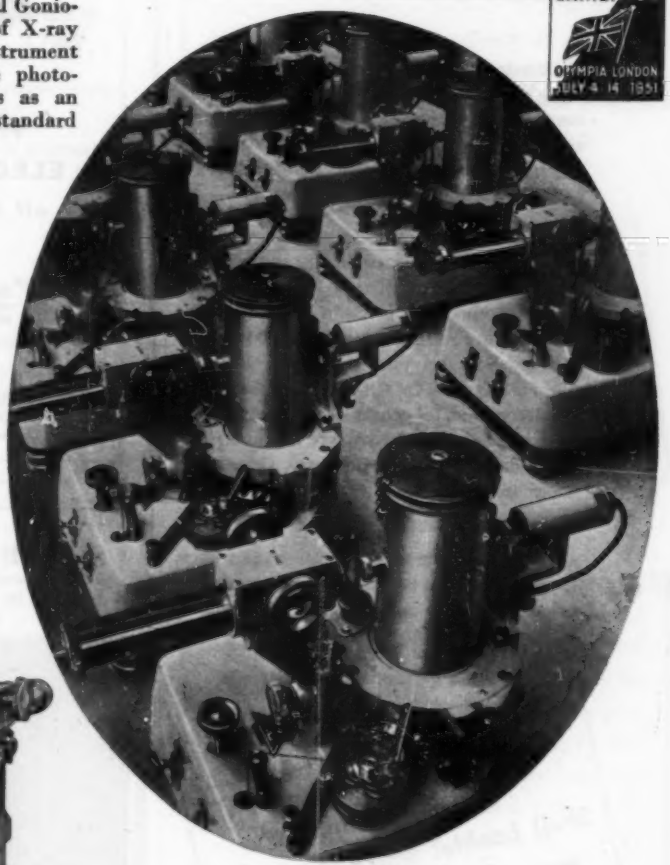
BRITISH INSTRUMENT INDUSTRIES EXHIBITION
OLYMPIA LONDON JULY 4-14 1951

The Unicam S.25 Single Crystal Goniometer is adaptable for a variety of X-ray techniques. It is the standard instrument for oscillation, rotation and Laue photographs. It is also used sometimes as an optical goniometer. Examples of the standard instrument are shown on the right. Flat plate, back reflection and radial cameras are available as accessories.

An important feature of the instrument is the goniometer head which is interchangeable with other Unicam instruments. The head is fitted with two slides and two arcs graduated in 2° intervals with a vernier. Movement is effected by a worm operated by a key. The cylindrical camera has an effective radius of 30.0 mm.

A comprehensive brochure which describes the techniques for which the Unicam S.25 Goniometer may be employed and the range of accessories which can be supplied will be sent on request.



The illustration on the left shows the Unicam S.25 Goniometer used with the flat plate camera (film or plate size $3\frac{1}{4}'' \times 4\frac{1}{4}''$). This camera is mounted on a slide having an engraved scale and the camera may be set at any distance from the crystal between 40 mm. and 100 mm.

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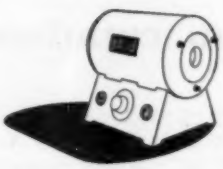

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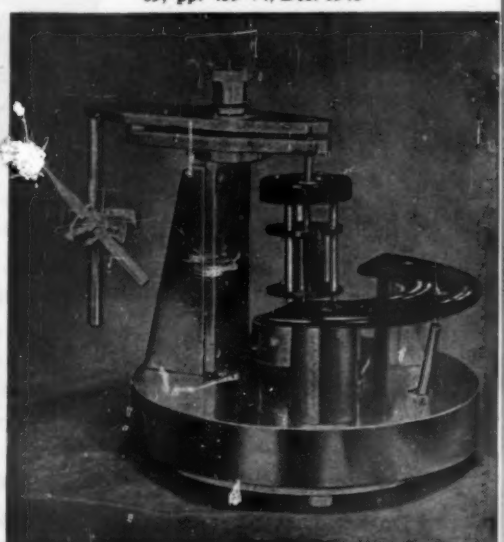
(patent application 11559/48: Foreign patents pending)

As described by Barer and Saunders-Singer, Q.J.M.S., Vol. 89, pp. 439–74, Dec. 1948



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Hanger: J. Clin. Invest. 18:261:1939.

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A stabilized rabbit brain substance for use in determining the Prothrombin Time of Blood.

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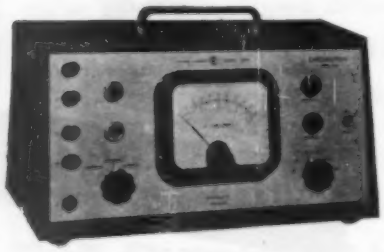

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LECTURES AND COURSES

COUNCIL FOR THE PROMOTION OF FIELD STUDIES

The following residential courses will be held at the Council's Field Centres during 1951: Meteorology (in co-operation with the Royal Meteorological Society). (1) Juniper Hall Field Centre, near Dorking, Surrey, September 5 to 12 (Introductory Course). Syllabus, the physical basis of meteorology; construction of weather maps, interpretation of climatic data; field exercises. (2) Malham Tarn Field Centre, near Settle, Yorkshire, September 5 to 12. Syllabus, the physical basis of meteorology with special reference to current weather. September 12 to 19 (more advanced course). Syllabus, methods used in forecasting; plotting of charts; taking readings; analysis of weather maps, etc. At all courses the current weather will be closely followed; instruction will be given in instrumental work, and discussions will be held on many aspects of weather study.

For further details of the above courses (and/or full field study programmes) apply without delay to the Director, Council for the Promotion of Field Studies, 10 Exhibition Road, South Kensington, London, S.W.7.

TRAINING OF TECHNICAL TEACHERS. Applications are invited from men and women of approximately 25 to 40 years of age for admission to a one-year course of training as full-time teachers of science in technical colleges and similar institutions. Applicants should have a university degree or be an Associate Member of a professional institution, or possess qualifications of the order of higher national certificate or full Technological Certificate of the City and Guilds of London Institute in the various branches of science, together with suitable experience in industry. The course will begin in September, 1951. Recognized students will be eligible for maintenance grants for the period of the course.

Further particulars and application forms may be obtained from the Director, Huddersfield Training College, Queen Street South, Huddersfield, Yorks.

OFFICIAL APPOINTMENTS

LANCASHIRE EDUCATION COMMITTEE

Applications are invited for the following post: Widnes Municipal Technical College. Full-time Teacher in the Chemistry Department, to teach Inorganic Chemistry. Applicants should possess a degree or equivalent qualification in chemistry, and industrial experience. Salary will be in accordance with the Burnham Technical Scale for Assistants, Grade A.

Application forms may be obtained from Mr. W. R. Wainwright, B.A., Education Office, Lugsdale Road, Widnes, to whom they should be returned within fourteen days from the appearance of this advertisement.

A. L. BINNS,
Chief Education Officer.

County Hall,
Preston.

UNIVERSITY OF GLASGOW VETERINARY SCHOOL

SENIOR LECTURER IN ANIMAL HUSBANDRY

Applications are invited for appointment to a Senior Lectureship in Animal Husbandry in the University Veterinary School. Salary scale £1,150 to £1,400. Initial salary according to experience and qualifications. F.S.S.U. and family allowance benefits.

Applications (six copies) should be lodged not later than July 14, 1951, with the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
Secretary of University Court.

UNIVERSITY OF GLASGOW VETERINARY SCHOOL

SENIOR LECTURER IN CLINICAL DEPARTMENT

Applications are invited for appointment to a Senior Lectureship in the Clinical Department of the University Veterinary School. Salary scale £1,150 to £1,400. Initial salary according to experience and qualifications. F.S.S.U. and family allowance benefits.

Applications (six copies) should be lodged not later than July 14, 1951, with the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
Secretary of University Court.

SOUTHERN RHODESIAN GOVERNMENT

DIVISION OF AGRICULTURE AND LANDS (CHEMISTRY BRANCH)
VACANCIES : CHEMISTS

Candidates must possess a four-year university degree in science with chemistry as a major subject. Experience in analytical work is essential and a specialized knowledge of pedology or soil science would be desirable, though not essential qualification. Salary scale, £600 by £34 to £668 by £33 to £800 by £100 to £900 by £40 to £1,140 per annum. The commencing salary may be higher than the minimum in recognition of approved previous experience. In addition to salary a cost-of-living allowance (approximately 20 per cent of salary) and marriage and children's allowances are payable in terms of the regulations. The successful applicants will be employed in the first instance mainly in chemical laboratories in Salisbury, but may later be called upon to carry out soil investigations or soil survey work in any part of the colony. Appointments are subject to the rules and regulations of the Southern Rhodesia Civil Service.

Application forms may be obtained from the Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2, to whom completed forms should be returned not later than July 28, 1951. Details of leave conditions, pension scheme, cost-of-living, marriage and children's allowances, income tax, medical examination, refund of sea and rail fares on appointment, etc., may be obtained from the High Commissioner's Office. Canvassing will disqualify applicants.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Applications are invited for an unestablished post in the Hydraulics Research Organization (Department of Scientific and Industrial Research), Wallingford, Berks, to be graded at Assistant Experimental Officer or Experimental Officer level, according to qualifications and experience. The officer selected will be required to assist in hydrographic surveying of beaches and estuaries and also to assist in research into the effect of waves and currents on beaches; experience in hydrographic surveying is desirable but not essential. Candidates should possess a higher national certificate or a higher school certificate with mathematics or a science subject as a principal subject, or an equivalent qualification, and should have experience in land surveying and be a good draughtsman. A knowledge of coastal waters gained from the handling of small boats would be considered a valuable qualification. Candidates must be willing to live in temporary accommodation for half the year and must have particularly good health. The salary range is £276 to £645. Candidates should have been born not later than August 1, 1930.

Write, quoting reference No. E270/51, to Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, for application forms. Closing date July 28, 1951.

THE CIVIL SERVICE COMMISSIONERS invite applications for permanent appointments as Senior Scientific Officer and Scientific Officer to be filled by competitive interview during 1951. Interviews began in January and will continue throughout the year, but a closing date for the receipt of applications earlier than December, 1951, may eventually be announced. Successful candidates may be appointed immediately. The posts are in various Government departments and cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. Candidates must have obtained a university degree with first- or second-class honours in a scientific subject (including engineering) or in mathematics, or an equivalent qualification, or possess high professional attainments. Candidates for Senior Scientific Officer posts must in addition have had at least three years' postgraduate or other approved experience. Candidates for Scientific Officer posts taking their degrees in 1951 may be admitted to compete before the result of their degree examination is known. Age limits: For Senior Scientific Officers, at least 26 and under 31 on August 1, 1951; for Scientific Officers, at least 21 and under 28 (or under 31 for established Civil Servants of the Experimental Officer class) on August 1, 1951. Salary scales for men in London, Senior Scientific Officers £700 by £25 to £900; Scientific Officers £400 by £25 to £650; rates for women are somewhat lower.—Further particulars from the Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3399.

COMMONWEALTH of AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
(DIVISION OF INDUSTRIAL CHEMISTRY)
APPOINTMENT NO. 3460

Applications are invited for appointment to a position of Research Officer, Organic Chemistry Section, Division of Industrial Chemistry. Location: Fishermen's Bend, Melbourne, Victoria. Duties: To aid with investigations in progress on the chemistry and the refining of cane and other waxes. Qualifications: University degree with honours in science, with chemistry as the principal subject, or equivalent qualifications, and some subsequent experience in research either in a university or in industry. Special knowledge of the chemistry of higher aliphatic compounds would be a desirable, but not necessary, qualification. Salary: Within the range of Research Officer, £A698 to £A1,100 per annum (actual), thirteen increments. Salary includes a cost-of-living adjustment of £A246 per annum. Fare to Australia (including those of wife and family) will be paid. Appointee may be granted superannuation privileges.

Applications, referring to appointment No. 3460 and stating full name, place and date of birth, nationality, present employment, particulars of qualifications and experience, and of war service (if any), accompanied by names and addresses of at least two persons willing to act as referees, if so desired, and copies of not more than four testimonials, should reach the undersigned (from whom further particulars may be obtained) not later than July 28, 1951.

J. E. CUMMINS,
Chief Scientific Liaison Officer.
Australian Scientific Liaison Office,
Africa House,
Kingsway, London, W.C.2.

H.M. COLONIAL SERVICE

MALAYA

A Biochemist is required to carry out research and other routine work in the Institute of Medical Research, Federation of Malaya. The post is pensionable but the officer will be on agreement for three years in the first instance. Salary according to qualifications and experience in scale £700 to £1,652, including pensionable expatriation allowance. Cost-of-living allowance of between £336 and £707, according to salary and family commitments, is also payable. Government quarters and heavy furniture, if available, are provided at nominal rent. Officers occupying private quarters may be granted an assistance allowance towards rent. Income tax at local rates which are much lower than in United Kingdom. Free first-class passages for the officer, his wife and children under age of ten, not exceeding four persons besides himself, once each way during each tour of service. Leave at the rate of 45 days for each year of resident service. Free medical attention for officer, wife and children, but a charge is made for hospital maintenance. Candidates, who should be under 35, should possess a British honours degree in chemistry, or equivalent qualification, plus at least one year's approved postgraduate biochemistry experience. A Ph.D. in organic chemistry or equivalent postgraduate research experience is desirable.

Application should be made, giving brief particulars of qualifications and experience, to the Director of Recruitment (Colonial Service), 2 Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting reference 27106/49/51.

CITY OF LEICESTER EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY AND COMMERCE
Principal:
H. L. Haslegrave, Wh.Sc., M.A.(Cantab.), Ph.D.(Lond.), M.Sc.(Eng.), M.I.Mech.E., M.I.E.E.

APPOINTMENT OF FULL-TIME LECTURER IN PHYSICS

Applications are invited for appointment as full-time Assistant Lecturer in the School of Physics and Allied Science. Candidates should hold an honours degree in physics and have had good teaching experience. Familiarity with some branch of applied physics is desirable and industrial experience will be an added recommendation. Salary will be in accordance with the Burnham Technical Scale (1951) for Assistant Lecturers, grade B (£450 by £25 to £725) with allowances for degree, training, teaching, and approved industrial experience.

Forms of application and further details may be obtained from the Registrar, College of Technology and Commerce, The Newarke, Leicester, to whom the forms should be returned as soon as possible.

ELFED THOMAS,
Director of Education.

DEPARTMENT of SCIENTIFIC and INDUSTRIAL RESEARCH

PRINCIPAL SCIENTIFIC OFFICER

The Civil Service Commissioners invite applications for a Principal Scientific Officer post in the Mechanical Engineering Research Organization. Candidates must possess a first- or second-class honours degree, preferably in engineering, and have some industrial and research experience. The successful candidate will be required to develop and initiate research into mechanisms for application to mechanical engineering problems. Mathematical ability and experience in its application to the analysis of both the kinematic and dynamic conditions of operation of mechanisms is essential. A general knowledge of the use of mechanical, electrical, hydraulic, and pneumatic techniques for such a purpose is required. Experience in the use of servomechanisms would be an additional qualification. The officer appointed will be stationed at East Kilbride, near Glasgow, where housing accommodation is being made available, but in the first instance he will be required to work at the National Physical Laboratory, Teddington, Middlesex. Candidates must have been born on or before August 1, 1920. Inclusive salary scales: £980 to £1,335 (men), £860 to £1,170 (women) at Teddington; £960 to £1,295 (men), £840 to £1,140 (women) at East Kilbride. Exceptionally a starting salary above the minimum of the scale may be granted according to qualifications and experience. The post is superannuable under the F.S.S.U.

Further particulars and application forms from the Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S4041/51. Completed application forms must be returned by July 26, 1951.

UNIVERSITY OF MALAYA

SINGAPORE

Applications are invited for the post of Assistant Curator of the Pathological Museum (The Keith Museum) of the university. The appointee will be required to supervise and assist in the selection, preparation and display of specimens and records in the museum and to undertake such teaching duties as might be directed. A medical qualification and experience in general pathology and of modern museum work will be required. Salary on the scale £854 by £42 to £1,400 per annum. Expatriation allowance for overseas recruited staff £210 to £252 per annum. Cost-of-living allowance £210 to £525 per annum, according to personal circumstances. Temporary non-pensionable allowance payable to members of staff with medical qualifications £210 per annum. Salary paid in Malayan currency. Free passages for appointee, wife and children under 10 years of age. Part furnished quarters (if available) at rent not exceeding 10 per cent of salary, or allowance in lieu. Provident fund scheme on 10 per cent contributory basis.

Applications (six copies), with names of three referees and full details of qualifications and experience, should be sent to the Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1, from whom further particulars should be obtained. Closing date July 31, 1951.

UNITED BIRMINGHAM HOSPITALS

Applications are invited for the post of Assistant Physicist at the Radiotherapy Centre, Queen Elizabeth Hospital. Candidates must possess an honours degree in physics, and preference will be given to research experience in electronic physics, since research facilities are provided. The salary is the subject of negotiation through the Whitley Council and, pending the outcome, the commencing salary will be £450 per annum.

Applications, together with the names of two persons to whom reference may be made, and stating the earliest date the candidate can take up his duties, should be sent to the Secretary, United Birmingham Hospitals, The Queen Elizabeth Hospital, Birmingham, 15, within fourteen days of the appearance of this advertisement.

GROUP LABORATORY

MILE END HOSPITAL,
BANCROFT ROAD, LONDON, E.1

Biochemist required for biochemical department of the Group Laboratory. A medical qualification is not essential, but experience in hospital biochemistry is necessary. Provisional salary (pending Whitley Council award) £800 by £40 to £1,100 per annum, according to qualifications and experience.

Applications and testimonials to the Secretary, Stepney Group Hospital Management Committee, Raine Street, Wapping, E.1, before July 7, 1951.

THE DEFENCE RESEARCH BOARD REQUIRES A SONICS SCIENTIST

SALARY: Dependent on qualifications and experience.

DUTIES: To be responsible for a sonics section with a staff of several junior scientists; will be required to work on fundamental sonics problems in voice communication, speech intelligibility; measurement of hearing losses in humans and noise and blast problems.

QUALIFICATIONS: A physicist or biophysicist with a Ph.D. degree; good grounding in acoustics with two or more years experience in sonics research, British subject.

APPLY TO:—

Director of Research Personnel,
Defence Research Board,
Department of National Defence,
"A" Building, Ottawa, Ontario.

Please refer to Competition G-8.

GOVERNMENT OF EAST BENGAL

(EASTERN PAKISTAN)

Applications are invited for the post of Director of Fisheries, East Bengal, whose duties will be the organization and development of fisheries and fish industries and the exploitation of existing fishery resources, on scientific lines and the most economical basis. Contract for five years (renewable for a further like period), terminable by six months' notice on either side. Non-pensionable, but with option of contributory provident fund. Qualifications: good science degree in chemistry or zoology, thorough knowledge of biology or fresh-water, estuarine and marine fish, and working knowledge of oceanography and hydrology, habits and habitats of sea fishes and sea animals and their commercial utilization; experience in fish cultural practices in tropical waters, fishing methods (preferably including deep-sea) and craft and gear design, fish marketing, storage and refrigerated transport, ability to organize canneries, smoke-houses, cold storage plants, ice factories and oil refinery plants; administrative and supervising ability and experience. Age not less than 35 years. Pay scale, Rs.1,500 by 50 to 2,000 per month. (Pakistani rupee equals approximately 2s. 2d.). Free passage out and back, including family. Leave.

Applications, on the form to be obtained on request, should be made to the High Commissioner for Pakistan, 35 Lowndes Square, London, S.W.1. Closing date for the receipt of completed applications July 16, 1951.

UNIVERSITY COLLEGE OF NORTH WALES

BANGOR

Applications are invited for the post of Research Demonstrator in Botany at a salary of £300 per annum. Preference will be given to candidates with research interests in some branch of botany other than plant physiology or mycology.

Applications must reach the undersigned, from whom further particulars can be obtained, not later than July 14, 1951.

KENNETH LAWRENCE,
Secretary and Registrar.

AUCKLAND UNIVERSITY COLLEGE

(NEW ZEALAND)
AMENDED ADVERTISEMENT

Applications are invited for a Lecturer in Mathematics. The salary scale for a Lecturer is £800 (N.Z.) per annum, rising to £950 (N.Z.) per annum by annual increments of £50 (N.Z.). The Lecturer will be expected to take up his duties as soon as possible after appointment.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1. The closing date for the receipt of applications is August 15, 1951.

MONMOUTHSHIRE EDUCATION COMMITTEE

(TECHNICAL COLLEGE OF MONMOUTHSHIRE)

Principal: Dr. T. V. Starkey, F.Inst.P.

Required to commence duties on September 1 next, or as soon as possible after that date, a Lecturer in Metallurgy. Candidates must hold a degree or equivalent qualification in metallurgy, and industrial experience would be an added recommendation. The person appointed will be required to teach metallurgy and related subjects to the standard of the ordinary national certificate. Salary will be in accordance with the Burnham Technical Scale (1951) at a grade to be determined at the time of the interview.

Forms of application and further particulars can be obtained by sending a stamped addressed foolscap envelope to the undersigned, to whom forms must be returned not later than fourteen (14) days after the appearance of this advertisement.

C. E. GITTINS, M.A.,
Director of Education.

County Hall,
Newport.

BRADFORD EDUCATION COMMITTEE

TECHNICAL COLLEGE, BRADFORD

Applications are invited for appointment as a whole-time Lecturer in the Department of Physics. The appointment is at present graded as Senior Assistant according to the Burnham Scale, with a salary range including allowances from £700 to £900 per annum. The status and the salary of the post is now under consideration, and will be regraded under the new Burnham Award.

Further particulars of the appointment and forms of application may be obtained from the Director of Education, Town Hall, Bradford, and completed forms should be returned to the Principal of the College as soon as possible.

A. SPALDING,
Director of Education.

AUCKLAND UNIVERSITY COLLEGE

(UNIVERSITY OF NEW ZEALAND)
SCHOOL OF ENGINEERING
AMENDED ADVERTISEMENT

Applications are invited for the position of Senior Technician and Workshop Supervisor to take charge of workshops and assist with design of research apparatus. Applicants should have experience in this class of work in a research organization. Salary scale £736 to £793 (N.Z.) per annum. House available at moderate rental.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1. The closing date for the receipt of applications is August 15, 1951.

UNIVERSITY COLLEGE OF WALES
ABERYSTWYTH
(WELSH PLANT BREEDING STATION)

Applications are invited from candidates possessing a good honours degree in botany or agricultural botany for appointments to fill two vacancies in the Scientific Officer grade. One in grass breeding and one in grassland agronomy. Candidates for the former post should preferably possess specialized training and interest in plant genetics and, for the latter, training in ecology and a knowledge of grassland farming. Salary according to experience and qualifications.

Further particulars can be obtained from the Registrar, to whom applications should be sent with testimonials, and the names of two persons to whom reference can be made, by July 14, 1951.

SUNDERLAND EDUCATION COMMITTEE
(THE TECHNICAL COLLEGE)

Applications are invited for the post of Lecturer in Mathematics. The work of the department ranges from National Certificate to B.Sc. Special (London), and applicants should be capable of undertaking work in any section. The salary for this appointment is under consideration, but will possibly be in accordance with the Burnham Technical Scale for Lecturers (£900 by £25 to £1,000). Duties to commence as soon as possible.

Forms of application and further particulars may be obtained from the Registrar, the Technical College, Sunderland, Co. Durham. Applications should be returned to the undersigned within two weeks after the appearance of this advertisement. Canvassing until after the first selection of candidates will be a disqualification.

W. THOMPSON,
Director of Education.

Education Offices,
15 John Street,
Sunderland.

AGRICULTURAL RESEARCH COUNCIL

A vacancy exists for a Chemist on the staff of the Council for work on the co-ordination of research and development on insecticides and fungicides. Applicants for this post should hold a first- or second-class honours degree, or its equivalent, and have had research experience in this field. Experience of the supervision of work of other investigators and some administrative experience are also desirable. An appointment will be made in the Scientific Officer or Senior Scientific Officer grade; salary range, Scientific Officer £400 to £650 (men), £400 to £525 (women); Senior Scientific Officer £700 to £900 (men), £575 to £800 (women); according to age, qualifications, experience, etc., with participation in the F.S.S.U.

Applications should be addressed to reach the Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1, not later than two weeks after the appearance of this advertisement, and should include the names of two referees.

THE CIVIL SERVICE COMMISSIONERS give notice that an open competition for pensionable appointment to the Assistant (Scientific) Class (basic grade) will be held during 1951. Interviews will be held throughout the year, but a closing date for the receipt of applications earlier than December, 1951, may eventually be announced either for the competition as a whole or in one or more subjects. Successful candidates may expect early appointments. Candidates must be at least 17½ and under 26 years of age on January 1, 1951, with extension for regular service in H.M. Forces, but other candidates over 26 with specialized experience may be admitted. All candidates must produce evidence of having reached a prescribed standard of education, particularly in a science subject, and of thorough experience in the duties of the class gained by service in a Government department or other civilian scientific establishment or in technical branches of the Forces, covering a minimum of two years in one of the following groups of scientific subjects: (i) engineering and physical sciences; (ii) chemistry, biochemistry and metallurgy; (iii) biological sciences; (iv) general (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing). Salary according to age up to 25, men £215 (at 18) to £330 (at 25) to £455; rather less in the provinces and for women. Opportunities for promotion.—Further particulars and application forms from Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S59/51. Completed application forms should be returned as soon as possible.

SOUTHERN RHODESIA GOVERNMENT
VACANCY: SENIOR PROFESSIONAL OFFICER
SABI VALLEY EXPERIMENTAL STATION
DIVISION OF AGRICULTURE AND LANDS

Applicants should possess an honours degree in agriculture of an approved university, normally involving a 4-year course, or some equivalent qualification. Candidates should have specialized in field crops and in soil physics and chemistry. Salary scale £1,180 by £40 to £1,340 per annum. In addition a cost-of-living allowance, varying between £202 and £205 per annum, is payable. The appointment will be subject to the rules and regulations of the Southern Rhodesia Civil Service.

Applications (in duplicate), giving full details of age, nationality, marital state, qualifications, experience, the names of two persons to whom reference may be made, together with copies of testimonials, should be submitted to the Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2, not later than July 15, 1951. Details of leave conditions, pension scheme, children's allowances, medical examination, refund of sea and rail fares on appointment, etc., may be obtained from the High Commissioner's Office. Canvassing will disqualify applicants.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
(CITY AND GUILDS COLLEGE)

Lecturer required in Electrical Engineering Department from October 1, 1951, commencing salary between £600 and £750 in the Lecturer scale (according to experience and qualifications) with F.S.S.U. and family allowances. Industrial or analogous experience desirable, with special interests and experience in radio engineering, with particular reference to micro-wave technique.

Applications, accompanied by full statements of qualifications and with references, should be sent to the Head of the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S.W.7, not later than July 16, 1951.

NORTH STAFFORDSHIRE TECHNICAL COLLEGE
STOKE-ON-TRENT

Principal: H. W. Webb, O.B.E., D.Sc.

Applications are invited for the full-time appointment of Lecturer in Physics, to begin duties as soon as possible after September 1, 1951. Applicants should be qualified to take classes up to Final B.Sc. standard. Industrial and/or research experience would be an advantage. Salary according to the Burnham Technical Scale for Lecturers, £900 by £25 to £1,000.

Applications, giving details of qualifications and experience, should be sent to the Principal immediately.

H. DIBDEN,
Clerk to the Governors

BIRKBECK COLLEGE
(UNIVERSITY OF LONDON)

It is proposed to proceed to the appointment of an Assistant Lecturer in Botany at an initial salary of £450 per annum, rising by annual increments of £50 to a maximum of £550.

For further particulars please write within ten days of the date of this advertisement to the Clerk, Birkbeck College, E.C.4.

THE AGRICULTURAL RESEARCH COUNCIL invite applications for the post of Dairy Cattle Husbandry Officer in their Animal Breeding and Genetics Research Organization, Edinburgh. This officer will be required to contribute to the practical planning, supervision and interpretation of experiments, and his duties will include advising the director on farming policy and practice in relation to the efficient management of the Organization's dairy cattle research stations. It is hoped to secure an officer with sufficiently high qualifications and experience to justify an appointment within the salary range of £980 to £1,335 per annum. Failing this the appointment may be within the range of £685 to £880 per annum, with prospect of promotion to the higher scale in due course. In either case applicants must possess a degree or an equivalent qualification in agricultural science, with appropriate postgraduate experience. Superannuation in accordance with the F.S.S.U.—Applications, with the names of three persons to whom reference can be made, should be addressed, not later than two weeks after the appearance of this notice, to the Director, Animal Breeding and Genetics Research Organization, "Glenbourne," South Oswald Road, Edinburgh, 9, from whom further particulars may be obtained.

HOSPITAL MANAGEMENT COMMITTEE
HACKNEY GROUP NO. 6
MOTHERS' HOSPITAL (SALVATION ARMY)
LOWER CLAPTON ROAD, E.5
(MATERNITY, 110 BEDS)

Senior Medical Laboratory Technician required for vacancy arising August 1, 1951. Candidates should possess the Associateship or the Fellowship of the Institute of Medical Laboratory Technicians. Experience in blood grouping is an advantage, but is not essential. Terms and conditions of service as recommended by the appropriate Whitley Council (salary £450 by £20 to £530 per annum, plus London weighting allowance on age basis).

Applications, on forms to be obtained from the undersigned, should be completed and returned within ten days of the appearance of this advertisement.

J. D. B. MANNING,
Group Secretary

Hospital Management Committee,
Group Administrative Offices,
Hackney Hospital, E.9.

UNIVERSITY OF NATAL
DURBAN, SOUTH AFRICA

Applications are invited for the following posts: 1. Lectureship in Civil Engineering; 2. Lectureship in Mechanical Engineering. Salary scales for both posts £550 by £25 to £750, plus cost-of-living allowance, at present £256 for married men and £109 for single men.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1. The closing date for the receipt of applications is August 1, 1951.

UNIVERSITY OF ADELAIDE

The University invites applications for appointment as Reader in German. Salary range £A1,250 to £A1,450, with superannuation benefits similar to F.S.S.U. Duties: The Reader will be in charge of the Department of German Language and Literature, and will be expected to develop an honours school.

Detailed terms of appointment and a statement about the work and desired development of the department may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1. Applications, in duplicate, should reach the Registrar, the University of Adelaide, Adelaide, South Australia, not later than July 31, 1951.

V. A. EDGELOE,
Acting Registrar.

MIDDLESEX COUNTY COUNCIL
(EDUCATION COMMITTEE)
ENFIELD TECHNICAL COLLEGE
QUEENSWAY, ENFIELD

Required for September 1, 1951, Lecturer in Physics to teach physics to B.Sc. (General) degree standard. Applicants must be honours graduates in physics with teaching and industrial experience. Salary in accordance with Burnham Technical Award, 1951, on scale £900 by £25 to £1,000.

Forms of application may be obtained by sending a stamped addressed foolscap envelope to the Principal, to whom completed forms should be returned within fourteen days of the appearance of this advertisement.

T. B. WHEELER,
Chief Education Officer.

METALLURGISTS, PHYSICISTS, AND PHYSICAL Chemists required by the Division of Atomic Energy (Production), Research and Development Branch (Metallurgical), to undertake a wide range of experimental work in normal and radioactive metallurgy, including physical metallurgy, melting, crystallography, physics, properties of metals and alloys, corrosion, powder metallurgy, creep and mechanical testing and chemical thermodynamics. There are vacancies at Risley, near Warrington; Springfields Factory, Salwick, near Preston; and Windscale Works, Sellafield, Cumberland. Candidates must have at least a higher school certificate in science subjects, or equivalent qualification, but possession of higher qualifications would be an advantage. Experience of experimental work is essential for the higher posts. Salary will be determined on age and on an assessment of the successful candidates' qualifications and experience within the following ranges: Senior Experimental Officer (minimum age 35) £742 to £960; Experimental Officer (minimum age normally 28) £545 to £695; Assistant Experimental Officer £240 (at age 18) to £505. Rates for women are somewhat lower in all grades.—Applications to Ministry of Supply, D.At.En.(P), Risley, near Warrington, Lancs, stating post applied for.

UNIVERSITY COLLEGE OF NORTH STAFFORDSHIRE

APPOINTMENT OF TECHNICIAN (DEPARTMENT OF BIOLOGY)

Applications are invited for the post of Technician (Zoological) in the Biology Department of the University College. Candidates should be fully conversant with the preparation of slides and demonstration materials for class and museum purposes. Salary scale £351 by £13 to £468 per annum, initial salary depending upon qualifications, with superannuation (5 per cent and 10 per cent), and child allowance of 6s. per week.

Applications should be submitted to the Registrar, the College, Keele, Staffordshire, not later than July 13, 1951, in an envelope marked "Technician—Biology Department."

CHELSEA POLYTECHNIC

(DEPARTMENT OF CHEMISTRY)

Senior Laboratory Technician required. Duties will include preparation for lectures and practical classes, maintenance of laboratories and workshop practice. Candidates should have a familiarity with physical chemistry apparatus. The salary will be £275 per annum, rising by annual increments of £20 to £355 per annum. There is at present a cost-of-living addition of 10 per cent. Appointment to take effect from September 1, 1951.

Applications, containing details of experience and supported by two testimonials, should be returned to the Head of the Department of Chemistry, Chelsea Polytechnic, Manresa Road, S.W.3, not later than July 19, 1951.

UNIVERSITY COLLEGE OF NORTH STAFFORDSHIRE

Applications are invited for the post of Technician (male or female) in the Geography Department. Salary range £351 by £13 to £468, with superannuation and children's allowances. Duties will include cartography, supervision of surveying and meteorological instruments, and maintenance of map collection. Residential accommodation may be available.

Further particulars from Professor of Geography, University College of North Staffordshire, Keele, Staffordshire.

UNIVERSITY OF NOTTINGHAM

(SCHOOL OF AGRICULTURE)

Applications are invited for the post of Demonstrator in Botany at the School of Agriculture, Sutton Bonington. Salary scale £350 by £25 to £400. Candidates must be university graduates, and preference will be given to those with special qualifications in agricultural botany.

Form of application and conditions of appointment may be obtained from the undersigned.

H. PICKBOURNE,
Registrar.

ASSISTANT EXPERIMENTAL OFFICERS (including biologists) in various Government Departments. The Civil Service Commissioners invite applications for the permanent appointments. Interviews will be held shortly after the receipt of the completed application form and successful candidates may expect early appointments. The posts are in various Government departments and divided between following main groups and subjects: (a) mathematical and physical sciences, (b) chemistry and metallurgy, (c) Engineering subjects, and (d) miscellaneous (including e.g., geology, library and technical information services). A few vacancies have now arisen for Biologists interested in pest infestation control, forensic science, or fisheries problems, and there may be one or two posts for biologists with other interests. Candidates must be at least 17½ years and under 26 years of age (or under 31 for established Civil Servants of the Assistant (Scientific) Class) on August 1, 1950; time spent on a regular engagement in H.M. Forces may be deducted from actual age. Candidates must have obtained the higher school certificate with mathematics or a science subject as a principal subject, or an equivalent qualification; but candidates without such qualifications may be admitted exceptionally on evidence of suitable experience. Higher qualifications will be regarded as an advantage to candidates over the age of 20. The inclusive London salary scale (men) is £250 to £535; (women) £250 to £445. Salaries for posts in the provinces are somewhat lower. Superannuation provision is made under the Superannuation Act. —Further particulars and forms of application from the Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3068. Completed application forms should be returned as soon as possible, and must in any case be received not later than October 1, 1951.

CHESHIRE EDUCATION COMMITTEE

CHESHIRE SCHOOL OF AGRICULTURE, REASEHEATH, NANTWICH

Applications are invited from men or women for the residential post of Lecturer in Agricultural Sciences. A university degree in science, together with qualifications in scientific agriculture (or an agricultural degree with additional qualifications in science), and experience in teaching are essential. Salary according to Burnham Scale for Teaching Staff of Farm Institutes, 1951, with a deduction of £104 per annum for board and lodging. The post is pensionable and evidence of medical fitness will be required.

Application forms and further particulars may be obtained by forwarding a stamped addressed foolscap envelope to the undersigned. Completed applications should be returned to the Principal, Cheshire School of Agriculture, Reasheath, Nantwich, within two weeks of the appearance of this advertisement.

JOHN G. KELLETT,
Director of Education.

County Education Offices,
City Road,
Chester.

UNIVERSITY OF MELBOURNE

AUSTRALIA

Applications are invited for the position of Lecturer in Economics. Salary range £A752 to £A1,102 (including cost-of-living allowance of £A102 at present), subject to superannuation contributions. A suitably qualified and experienced applicant could be appointed to the grade of Senior Lecturer, the salary range for which is £A1,102 to £A1,352, including cost-of-living allowance.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1. The closing date for the receipt of applications is July 31, 1951.

LONDON COUNTY COUNCIL

Laboratory Technician required immediately at Colls Road Secondary School, York Grove, S.E.15. Commencing rates of pay 57s. 6d., 65s., 72s. 6d., or 80s. a week at ages 16, 17, 18, or 19, respectively, and at age 20 or over £225 a year, rising by annual increments of £15 to a maximum of £315. A successful candidate under 20, if holding science qualification equivalent to Intermediate Science examination (London), would commence at £225. Laboratory Technicians who pass the Laboratory Technicians' Intermediate Certificate examination of the City and Guilds of London Institute, or hold an accepted equivalent qualification, will be granted an additional increment of £15 and will proceed to £345 a year by two increments beyond normal maximum of scale. All basic rates of pay are at present subject to increase of 10 per cent.

Application, by letter, to Headmaster at the School, stating age, qualifications and experience. (747).

NORTH OF SCOTLAND COLLEGE OF AGRICULTURE

The Governors invite applications for appointment as an Analytical Chemist, to be responsible for analytical work on grass and grass products. Applicants should have a degree in chemistry, biochemistry, or agricultural chemistry, preferably with honours. Salary scale: Honours graduates (men) £380 to £495, (women) £380 to £437; ordinary graduates (men) £330 to £495, (women) £330 to £437. The person appointed will be eligible for admission to a superannuation scheme.

Forms of application, which may be obtained from the undersigned, must be lodged not later than July 31, 1951.

HUGH MUNRO,
Secretary.

41½ Union Street,
Aberdeen.

UNIVERSITY OF SHEFFIELD

Applications are invited for a post of Research Demonstrator in Zoology, to begin duties on October 1, 1951. The Demonstrator will be required to give laboratory instruction of not more than twelve hours per week during each term, and to engage in research approved for a higher degree. Salary £300 per annum. The appointment will be for one year in the first instance, but will be renewable for two further years.

Applications (three copies), with the names and addresses of two referees, should reach the undersigned not later than July 21, 1951.

A. W. CHAPMAN,
Registrar.

EAST MALLING RESEARCH STATION

A Virologist (male) is required to undertake research on virus diseases of fruit and hops, with special reference initially to the latter crop. Entomological experience an advantage. Salary according to qualifications and experience within the Scientific Officer or Senior Scientific Officer scales of the Ministry of Agriculture, and Superannuation benefits under the F.S.S.U.

Further particulars and application forms can be obtained from the Secretary, East Malling Research Station, Maidstone, Kent, by whom applications should be received not later than July 16, 1951.

UNIVERSITY COLLEGE

IBADAN, NIGERIA

Applications are invited for appointment to the Chair of Agriculture. Salary £1,950 per annum. Family allowances £50 per annum per child (maximum £150 per annum). F.S.S.U. Part furnished residential accommodation at rent of 7.7 per cent of salary. Free passages for members of staff and wives on appointment, normal retirement, and annual leave in Europe.

Applications (six copies), giving full particulars of qualifications and experience and the names of three referees, should be sent to the Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1, from whom further information may be obtained. Closing date July 31, 1951.

UNIVERSITY OF NOTTINGHAM

(DEPARTMENT OF PHARMACY)

Applications are invited for the post of Laboratory Technician (grade III) in the above department. Salary scale £234 to £338 per annum. Candidates must possess either a national certificate or an equivalent qualification, and have experience in physiology or pharmacology.

Form of application and further information may be obtained from the undersigned.

H. PICKBOURNE,
Registrar.

WYE COLLEGE

(UNIVERSITY OF LONDON)

Applications are invited for the post of Assistant Lecturer in Botany, for B.Sc.(Agric.) and B.Sc.(Hort.) degree courses. Salary scale £450 to £550, according to qualifications and experience, with F.S.S.U. Appointment to date from October 1, 1951.

Further particulars from the Registrar, Wye College, Wye, Kent. Applications to be submitted not later than July 21, 1951.

UNIVERSITY COLLEGE OF SWANSEA

Applications are invited for the post of Lecturer in Metallurgy. Salary on the scale £590, rising annually by £50 to £1,100 per annum, with an efficiency bar at £850.

Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received without delay.

ST. MARY'S HOSPITAL MEDICAL SCHOOL

(UNIVERSITY OF LONDON)
PADDINGTON, W.2

Applications are invited for the appointment of RESEARCH TECHNICIAN to the Paediatric Unit. Salary £390 by £15 to £465, and superannuation.

Applications, stating age, qualifications and experience, should be sent to the Secretary by July 15, 1951.

HORTICULTURAL PRODUCTION AND Marketing Officer. The Land Settlement Association invites applications for the post of Horticultural Officer, who will be responsible for the application and supervision of horticultural production and marketing policy in connection with the Association's smallholding estates. The organization operates nurseries for the propagation of tomato and other plants and central packing stations for the marketing of produce. Applicants should have a wide experience of commercial horticultural production, including intensive cultivation under glass; experience of organized marketing, as well as familiarity with the main markets; and possess organizing and administrative ability. Salary £1,000 to £1,200 per annum, commencing salary according to qualifications and experience. Travelling expenses. Pension scheme. —Particulars and application form may be obtained from the Controller, 43 Cromwell Road, London, S.W.7, marking envelope "H.O."

THE JOINT BLOOD TRANSFUSION COMmittee of the S.E. and S.W. Metropolitan Regional Hospital Board invite applications for the post of Senior Technician in the South London Blood Transfusion Centre, Sutton, Surrey. The successful applicant will be required to act as deputy to the chief technician and must be capable of taking charge of a large staff. Other duties will be varied and will include bacteriology. Qualifications, salary and conditions in accordance with Whitley Council recommendations, plus London weighting.—Applications by July 28, 1951, together with three recent testimonials or names of referees, should be sent to the Regional Transfusion Officer, South London Transfusion Centre, Sutton, Surrey.

ENGINEER REQUIRED BY WELL-KNOWN Midland manufacturers, to take charge of small team of specialists developing the practical applications of semi-finished light alloys. The post, offering good prospects and scope for initiative, requires a graduate in one of the applied sciences whose experience has given him a broad outlook, the ability to lead others, and a taste for tackling a wide range of problems in the engineering fields. Salary will be offered commensurate with the candidate's abilities.—Box 590, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

PATHOLOGICAL TECHNICIAN REQUIRED. Qualifications as laid down by Whitley Council. Pay on scale £370 to £435. Staff of seven employed.—Apply, Secretary-Superintendent, Royal Surrey County Hospital, Guildford.

APPOINTMENTS VACANT

THE PARSONS AND MARINE ENGINEERing Turbine Research and Development Association requires a Thermodynamicist for work associated with the development of liquid cooled gas turbines for marine propulsion. Applicants should be British subjects with good qualifications and research experience.—Apply, in writing, stating salary expected, to the Research Director, Pametrada Research Station, Wallsend.

BELLING & LEE, LTD., 540 CAMBRIDGE Arterial Road, Enfield, Middlesex, wish to engage a Specialist, to conduct aerial research and development, particularly at television frequencies. Applicants must possess scientific qualifications, together with considerable experience in the field; must be imaginative and original, and able to work with minimum supervision. Excellent research facilities are available, and an attractive salary will be offered to the right applicant.

GRADUATE ELECTRICAL ENGINEER OR Physicist, sound knowledge of transmission line theory and practical experience in application of R.F. cables, to provide liaison with electronic research and industry home and abroad. Exceptional opening for right man.—Fullest details of qualifications, experience, age, etc., in confidence, to "G.E.E.," c/o Dixons, 1-9 Hills Place, Oxford Street, London, W.1.

THE RESEARCH DEPARTMENT OF THE Distillers Co., Ltd., have a vacancy for an experienced Mycologist for culture and investigational work on moulds associated with antibiotic research. Age up to 27 years. Applicants should have an honours degree in botany or equivalent qualification, and must possess some postgraduate experience in the antibiotic field. Salary will depend on experience and qualifications. Non-contributory pension scheme.—Apply, Staff Manager, 21 St. James's Square, S.W.1.

THE COAL TAR RESEARCH ASSOCIATION requires an Abstractor. Candidates (male or female) should have experience of abstracting technical literature, ability to translate from foreign languages, especially from German, some knowledge of chemical technology and preferably a science degree. Salary £375 to £600, according to age and qualifications. A superannuation scheme is in operation.—Applications to the Director of Research, The Coal Tar Research Association, Oxford Road, Gomersal, near Leeds.

PHYSICISTS AND ENGINEERS FOR INstrument work. Imperial Chemical Industries have vacancies in their Billingham Division for Physicists and Engineers, to carry out research and development on measuring, recording and automatic control instruments and to supervise works' use of them; also for experimental stress analysis. Candidates should be between 22 and 45 years of age. They must have an honours degree, and preferably some practical or research experience.—Please write, giving full details of qualifications and experience, etc., quoting ref. A.7, to the Staff Manager, Imperial Chemical Industries, Limited, Billingham Division, Billingham, Co. Durham.

DIGITAL COMPUTORS. FERRANTI, LTD., Moston, Manchester, are engaged upon the long term development and exploitation of digital computors. This interesting work covers vacuum physics, the electronic and electrical properties of materials, computing and pulse circuit techniques, electrical and mechanical recording, electro-mechanical mechanisms, precision mechanical engineering and power supply equipment. In the course of this work there are occasional vacancies for Senior Engineers with wide experience from whom enquiries will be welcomed at any time. There are immediate vacancies for: (1) Engineers and Scientists for research and development work in the above fields. Qualifications include a good honours degree in physics or engineering, or equivalent experience. Salary according to qualifications and experience in the range £450 to £1,000 per annum. Please quote Ref. D.C.E.; (2) Technical Assistants for experimental work in the above fields. Qualifications are a degree or higher national certificate in engineering, or equivalent. Salary according to age and experience in the range £350 to £650 per annum. Please quote Ref. D.C.A. The Company has a staff pension scheme and will give housing assistance in special cases.—Application forms from the Staff Manager, Ferranti Limited, Hollinwood, Lancs.

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YOUNG MEN OR WOMEN WITH H.S.C. or H.N.C., interested in physics or electricity, required for research and development work on semi-conducting devices. Salary according to age and qualifications.—Apply, stating age, qualifications, previous experience, etc., marking envelopes "Semi-Conductors," to Box 587, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

PHYSICISTS, HONOURS GRADUATES, REquired for basic research on semi-conducting materials, vacuum processes and allied subjects. Salary £450 per annum and upwards, according to qualifications and experience.—Reply, stating age, experience, qualifications, etc., marking envelopes "Physicists," to Box 586, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

ASSISTANT WORKS CHEMIST, AGED 20 to 25, academic qualifications an advantage but not essential.—Apply, stating details of experience and salary required, to Box 584, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

YOUNG GRADUATE IN PHYSICS REquired for the Research Development section of a Midland firm manufacturing goods using rubber and textile materials. Candidates must be thoroughly practical and adaptable men, and should have a flair for experimental work. An engineering aptitude and knowledge of textiles will be regarded as an asset.—Apply, stating age, experience (if any) and salary required, to Box 581, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

BELLING & LEE, LTD., CAMBRIDGE Arterial Road, Enfield, Middlesex, require Research Assistants in connection with work on electronic components, fuses, interference suppressors and television aerials. Applicants must be graduates of the I.E.E., or possess equivalent qualifications, together with similar laboratory experience. Salary will be commensurate with previous experience.—Applications must be detailed and concise, and will be treated as confidential.

ENGINEER OR PHYSICIST REQUIRED TO take charge of section developing thermionic transmitting valves. Hons. degree in physics or electrical engineering, or equivalent qualification, essential. Previous experience of transmitting valves desirable. Salary according to experience and suitability.—Apply, Personnel Manager, Standard Telephones and Cables, Ltd., Ilminster, Somerset.

ELECTRICAL ENGINEER NOT OVER 30, with interest in general physics, required for interesting work connected with the manufacture and development of infra-red spectrometers. A degree in electrical engineering or physics is desirable.—Apply, giving full details of qualifications, experience, age and salary, to Sir Howard Grubb, Parsons & Co., Walkergate, Newcastle-upon-Tyne, 6.

FERRANTI, LIMITED, MOSTON WORKS, Manchester, have staff vacancies in connection with long term development work on an important radio telecontrol project: (1) Senior Engineers or Scientists to take charge of research and development section. Qualifications include a good degree in physics or electrical engineering and extensive past experience in charge of development work. Salary according to qualifications and experience in the range of £1,000 to £1,500 per annum. Please quote reference R.S.E. (2) Engineers and Scientists for research and development work in the following fields: Radar, radio and electronic circuits, microwaves, high-power centimetric valves, vacuum and/or high voltage techniques, servo control and electro-mechanical devices. Qualifications include a good degree in physics or electrical engineering or mechanical science, or equivalent qualifications. Previous experience is an advantage but is not essential. Salary according to qualifications and experience in the range £420 to £1,000 per annum. Please quote reference R.T.E. (3) Technical Assistants for experimental work in the fields listed in (2) above. Qualifications required: a degree or higher national certificate in electrical or mechanical engineering, or equivalent qualifications. Salary in the range of £260 to £550, according to age and experience. Please quote reference R.T.A. The company has a staff pension scheme, and will give housing assistance in special cases.—Application forms from Mr. R. J. Hebbert, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs.

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DEVELOPMENT CHEMISTS REQUIRED for modern Electrolytic Alkali and Chlorine works in the North-West. The appointments are for a new department which is expected to expand rapidly. Applicants should have first- or second-class honours degree and should be under 30. Contributory pension scheme, housing scheme. Salary according to qualifications and experience.—Please apply to Technical Manager, Murgatroyd's Salt & Chemical Co., Ltd., Elworth, Sandbach, Cheshire.

BACTERIOLOGISTS, GRADUATES, AGE 21-26, required for antibiotic research and for work upon the biochemical aspects of virus chemotherapy. Experience in one of these fields is an advantage but not essential. Salary according to age and experience.—Applications, by letter, to Personnel Manager, Boots Pure Drug Co., Ltd., Station Street, Nottingham.

COURTAULDS, LTD., REQUIRE FOR their Research Laboratory at Droyisden, Manchester, Dyeing Technologists or Textile Chemists for research on dyeing, finishing and associated fibre properties. Applicants should be between the ages 20 and 35, and should possess either a degree or diploma in textile chemistry or dyeing technology, or should have had appropriate experience in the textile industry.—Candidates should write for a detailed form of application from the Director of Personnel, Courtaulds, Ltd., 16 St. Martin's-le-Grand, London, E.C.1, quoting the reference No. D.1.

CHEMIST REQUIRED TO JOIN SMALL group investigating the preparation of new, and modifications of known, synthetic resins and their possible application in the electrical industry. Good degree or A.R.I.C. essential; those who will qualify this year are also invited to apply.—Director of Research, the British Thomson-Houston Co., Ltd., Rugby.

CHEMIST REQUIRED FOR RECENTLYestablished Research Laboratory of high-grade Paper Mills in Staffordshire. Degree or A.R.I.C. required. High practical standard essential. Age 20-27; previous paper trade or research experience not essential. Salary according to qualifications and experience. This post should appeal to a man with wide interests and a practical outlook.—Please reply, in strict confidence, to Box 591, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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PERMANENT POST IN A LABORATORY required by unqualified lady biologist. Wales or near. Three years' university education in appropriate subjects. Good references. Now free to undertake duty. Age 21 years. Kindly state salary, etc.—Box 593, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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(TECHNICAL COLLEGE)
I.W.S. RESEARCH FELLOWSHIP

Applications are invited for a Research Fellowship provided by the International Wool Secretariat. The Fellowship will be of an annual value up to £700 for a candidate with suitable qualifications and experience. The Fellow should have chemical or biochemical qualifications and be able to undertake work on the chemistry of wool fibre. He will work in conjunction with Dr. F. Happey, head of the department of textile industries.

Applications should be forwarded as soon as possible to the Principal, Technical College, Bradford.

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

The above Association is offering four Bursaries for postgraduate research in Physical Chemistry, tenable at the Imperial College of Science and Technology. Applications for these bursaries are invited from graduates in chemistry, physics, or metallurgy, who are holders of a good honours degree. Researches cover fundamental investigations into the physical chemistry of liquid alloys, slags, and mixed oxide and metalgas systems. Value of the bursaries will be £250 to £315 per annum, according to age, qualifications and residence. Commencing October, 1951, these bursaries will be tenable for one year in the first instance, but, subject to satisfactory work and progress, they will be reviewed as necessary to complete the research which is intended to lead to the degree of Ph.D.

Written applications only, giving full curriculum vitae, to Personnel Officer, B.I.S.R.A., 11 Park Lane, W.1

UNIVERSITY OF LIVERPOOL

Applications are invited for the Herdman Postgraduate Studentship in Marine Zoology, value £200, tenable for one year but renewable for a second year. The Studentship is open to graduates in science, qualified and willing to carry out researches in marine zoology at the University of Liverpool and at the Port Erin Marine Biological Station or any other British marine biological station.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than July 14, 1951, by the undersigned, from whom further particulars may be obtained.

STANLEY DUMBELL,
Registrar.

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Applications from Electrical Engineers or Physicists are invited for a Research Fellowship, tenable in the Department of Electrical Engineering, for research in the field of vacuum insulation. The appointment will be for two years in the first instance, at a stipend of £600 per annum, plus superannuation benefits. The work will be carried out in the Particle Laboratory, and forms part of a programme sponsored by A.E.R.E., Harwell. It is not subject to any security restrictions, and would be suitable for submission in thesis form for a higher degree of the University of London. Applicants should provide evidence of research ability, and experience with vacuum, gas discharge, or high-voltage apparatus would be advantageous.

Applications should include names of referees familiar with the candidate's research ability and experience, and should be sent to the Registrar, Queen Mary College, Mile End Road, London, E.1, before September 1, 1951. Inability to accept appointment before the end of the 1951-2 academic year will not prevent consideration of an application.

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RADIATION LTD. RESEARCH FELLOWSHIP IN GASEOUS FUEL AND COMBUSTION

The purpose of the Fellowship is to enable a student to undergo training in research in relation to carbonization, gaseous fuels and combustion. An election to this Fellowship will be made in July, 1951. The Fellowship is tenable from October 1, 1951, and is of the value of £270 per annum and covers payment of college fees. It is awarded for one year in the first instance and may be renewed for a second year. Candidates should hold a degree in chemistry or chemical engineering.

Applications should be received before July 13, 1951, by the Registrar, Imperial College, Prince Consort Road, S.W.7, from whom further details may be obtained.

UNIVERSITY OF LEEDS
GAS RESEARCH FELLOWSHIP

A Fellowship, of the value of £325 a year, provided by the Institution of Gas Engineers, will be awarded by the Senate to a duly qualified candidate for the prosecution of postgraduate research in gas chemistry. Preference will be given to candidates who have signified their intention of entering the coal gas industry, or in default of any such candidate, to a person qualifying for some other branch of the fuel industry.

Applications should reach the Registrar, the University, Leeds, 2 (from whom further particulars may be obtained), not later than July 31, 1951.

GAS RESEARCH FELLOWSHIP ESTABLISHED BY THE NORTH THAMES GAS BOARD

The purpose of the Fellowship is to enable a student to undergo training in research in relation to carbonization, gaseous fuels and combustion. An election to the Fellowship will be made in July, 1951. The Fellowship is tenable from October 1, 1951, and provides for maintenance allowance of £220 per annum in addition to covering the college fees. It is awarded for one year in the first instance and may be renewed for a second year. Candidates should hold a degree in chemistry or chemical engineering.

Applications should be received by July 13, 1951, by the Registrar, Imperial College, Prince Consort Road, S.W.7, from whom further details may be obtained.

SCHOOL OF PHARMACY
(UNIVERSITY OF LONDON)
ALLEN AND HANBURYS RESEARCH FELLOWSHIP

Applications are invited for the above award, which is tenable in the Department of Pharmacology. The value of the Fellowship is £300 per year, and applicants must be pharmaceutical chemists or graduates in pharmacy, science or medicine of a university.

Details and forms of application may be obtained from the Secretary, 17 Bloomsbury Square, W.C.1. Applications should be received by September 1, 1951.

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